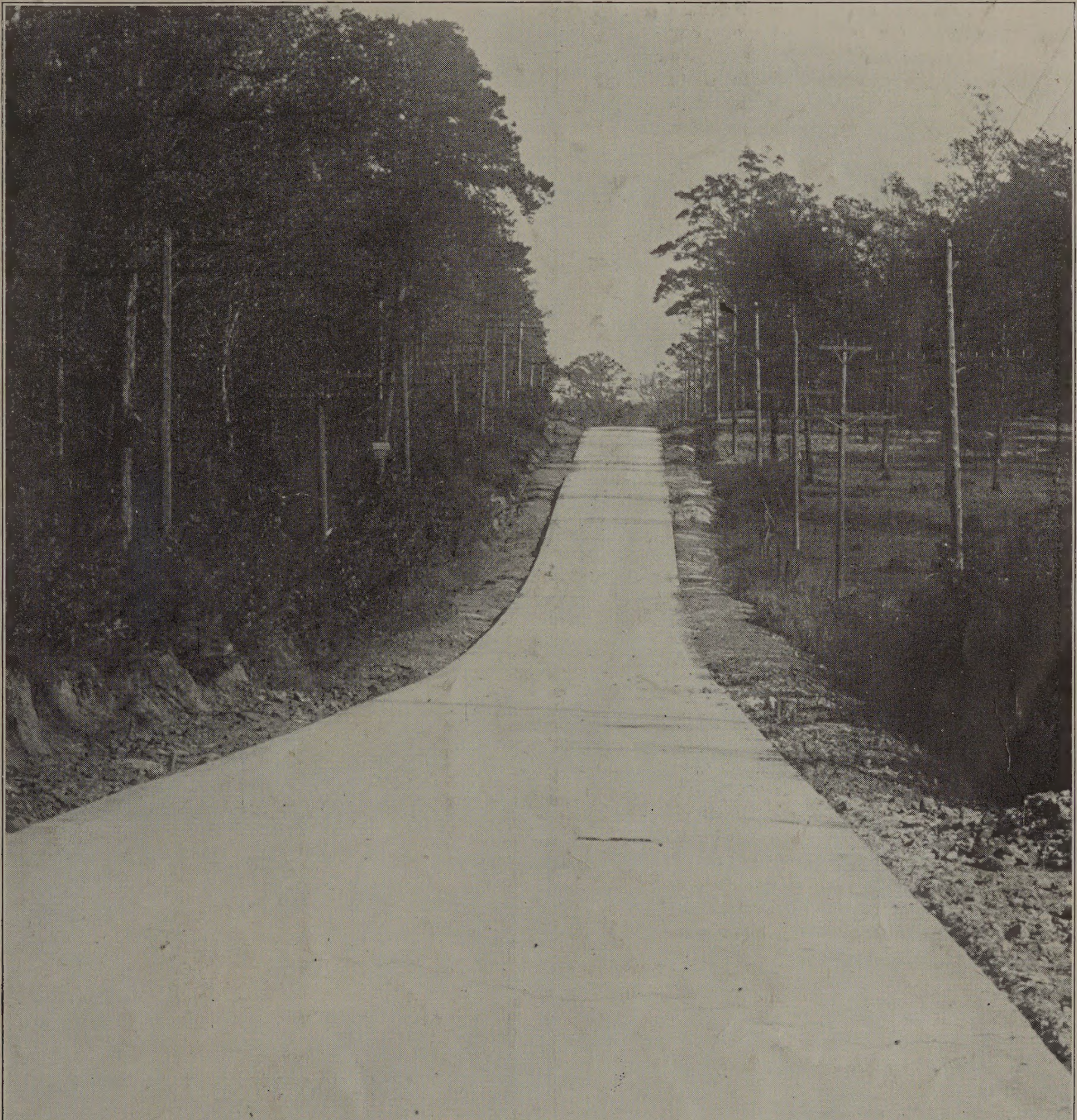
North Carolina Highway Bulletin

VOL. III MARCH, 1922 NO. 1



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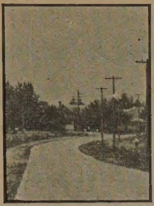
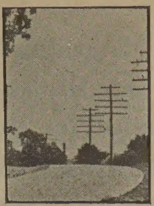


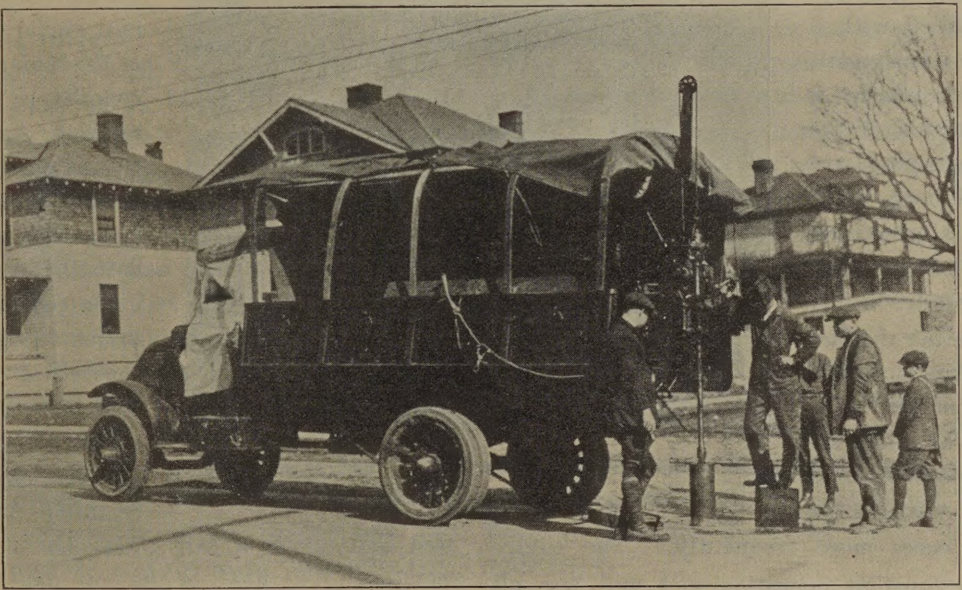
NORTH CAROLINA HIGHWAY BULLETIN



Vol. III, No. 1 **H. K. WITHERSPOON, Editor** **MARCH, 1922**

Calyx Core Drill Added *to* Testing Equipment *of* Commission

WITH a view to securing only the highest type of hard surface work on the State Highways the Commission has recently added to the equipment of the Division of Tests and Investigations a "Calyx" core drill or pavement testing machine with which it is possible to drill a core from any hard surfaced road and determine by tests whether or not the work has been done according to specifications. As soon as the cores are drilled from the pavement they are forwarded to the laboratory at Raleigh for measurement, strength tests and for analysis. With materials of known quality, as previously determined by tests, and for comparison, a laboratory test of the product made from these materials, it should become evident, as soon as the tests of the cores are completed, whether or not the highway in question has been built according to standard.



Core Drill Outfit and Crew Taking Sample of Pavement

The outfit which is in use by the Highway Commission is entirely mobile in order that it may be easily and quickly moved from one job to another. It is mounted on a three ton Kelly Springfield truck which, in addition to the drill proper, also carries molds for making concrete repair plugs; bins for sand, stone, and cement for repair plugs; a 130-gallon water tank and hand force pump so that the tank can be refilled from rivers or creeks; accessories for the work and for repairs.

As shown in the accompanying photograph the drill is mounted flush with the end of the truck body and is driven by a belt from an 8-horse power, two cylinder, four cycle gasoline engine mounted just to the rear of it. This engine has its own gasoline tank and radiator so that it is independent of the truck for power.

A patented type drill head, designed for road testing service is used and is capable of drilling from any hard surfaced road a core 6¼″ in diameter. The drill bit is of soft steel, cylindrical in shape and has a slightly rounded face. It is rotated at approximately 200 revolutions per minute on a thin layer of steel shot which are fed through the bit and which lie between the face of the drill and the material to be drilled. These shot are broken into small sharpedged pieces by pressure which is exerted on the drill as it rotates, and these pieces partially imbed themselves in the soft steel of the drill bit thus forming an abrasive surface which rapidly wears through the material on which it is placed.

Water is fed to the cutting face of the drill by means of the small pipe shown in the photograph on this page, and serves the double purpose of cooling the bit and of washing the pulverized material from the hole. Under average conditions about three gallons of water are

(Continued on next page)

Calyx Core Drill Added *to* Testing Equipment *of* Commission

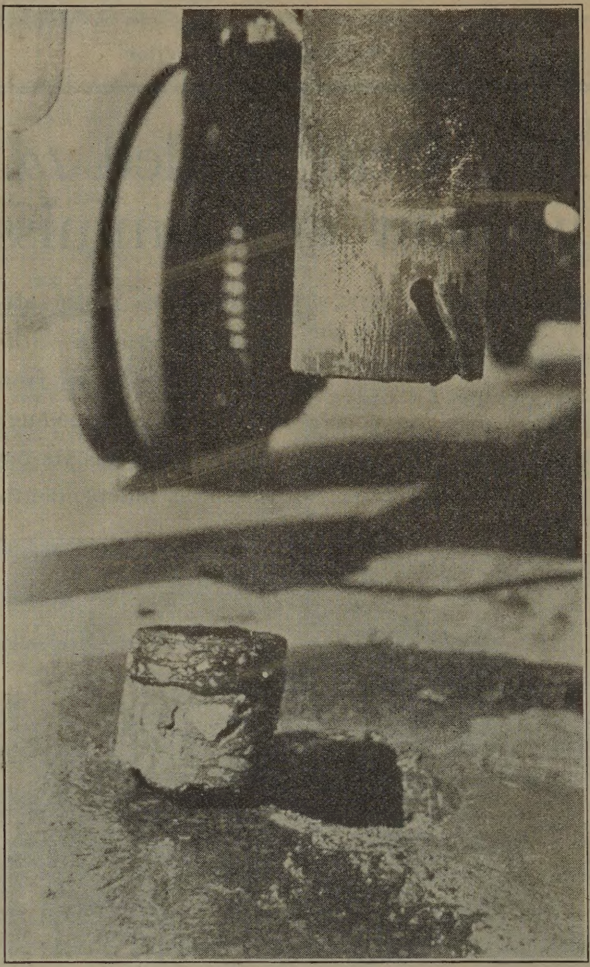
(Continued from page 3)

used in drilling a core from an 8 inch pavement. After the hole has been drilled through the pavement the bit is raised, the core lifted from the hole and marked for identification when shipped to the laboratory.

The guide board, shown in the photograph on page 3 to the left of the bit, is used for centering and holding the bit in place when starting a new hole. After penetrating half an inch the bit follows the groove which it has cut. The 7½ inch bit, which is the size used by the Commission, will drill through an 8 inch pavement in about 20 or 30 minutes, using approximately three pounds of shot.

The holes which are left in the pavement when the core is removed are filled with a concrete plug previously cast, the diameter of which is slightly less than that of the drilled hole. These plugs are quickly dropped into place and grouted with quick setting cement so that the road is left in good condition.

The crew operating the machine have a definite itinerary outlined for them and take samples at regular intervals along a given piece of road unless conditions warrant the drilling of test cores more frequently. The equipment will be in constant operation and will test all roads which have been laid as well as those which are under construction. In the future before a final estimate is paid on any hard surface work a satisfactory report on the core drilled from the corresponding pavement will be necessary. This is without a doubt the best way to insure that the State is getting value received for the money that it is spending for hard surfaced roads.



DRILL HEAD AND CORE SAMPLE FROM ASPHALTIC CONCRETE ROAD LAID ON A CEMENT CONCRETE BASE

The system which is carried out in testing materials for highway construction does not permit the use of any inferior material and the tests of the core drilled from the finished work will be final evidence of the quality of the materials entering into it. Before any source of material can be available for highway work the material must be tested and approved for use. After the first test the supply is frequently check tested to detect any variation in the quality of the materials and to insure compliance with the specifications. As soon as construction is started a daily record is kept of materials used and is checked against the amount actually required for the given price of work and any major deviations from the theoretical amount are investigated immediately. This allows a close check to be kept on the quality and quantity of the materials used and allows a full knowledge of detail regarding their use. The final, or the core drill test will be made when the work is completed to determine that the pavement has been built in accordance with the design as regard depth and quality of the different materials after fabrication into the finished product.

Road Building in United States with Federal Aid.

Good roads decrease the cost of transportation, permit the cultivation of crops not otherwise marketable, permit the marketing to be done when prices are most favorable, tend to equalize traffic between the different seasons of the year, facilitate the consolidation of rural schools, facilitate rural mail delivery, and are a material factor in inducing tourist travel. Trade follows the best route.

Standardization *of* Materials *and* Methods *in* North Carolina State Highway Construction

THE new specifications of the State Highway Commission will become effective on and after all projects let March 30, 1922, and will contain several changes from the former specifications. In their preparation consideration has been given to the progress made throughout the country in highway construction, and they are intended to standardize as far as possible, the methods and materials used in securing an economic high type of pavement.

Prominent among the features, relating to construction, is the sheet of adopted standards to guide the contractor when making his equipment for the hand finish of concrete wearing surfaces. This sheet includes details of the standard channel iron screed, the bow belt, the roller, and the subgrade check board, as well as minor equipment. It should be secured by all contractors who intend to finish the roadway by hand methods.

The use of boxes or other suitable means for measuring the aggregates for concrete mixtures is required, as usual, regardless of whether it is concrete base work or concrete wearing surface. This does not allow materials to be measured in truck bodies, but requires the aggregate to be struck off in boxes of the exact size necessary for a given sized batch, separate compartments being used for the fine and coarse aggregates. The use of the larger sizes of concrete mixers has led to a requirement of more exact proportioning of the individual aggregates, as a small deviation from the proper measurement in the depth of the box will have considerable effect on the proportions of the mixture on account of greater surface area of the larger batch boxes. Each box when struck off must give the proper proportions.

In general, the practice for concrete base work will be the same as is required for the one course Portland cement concrete roadway. The finish will necessarily be different, but the correctness of the proportions, the consistency of the mixture, and the check templates, etc., for the subgrade, as well as the condition of the subgrade prior to the placing of concrete upon it, will be the same as for the concrete roadway.

Particular attention will be given to the consistency and mixing of all concrete mixtures. A mixture which will quake but not settle when deposited will be required, as the exceedingly dry mixture has no place in concrete roadway construction. The use of a flowing consistency, however, will not be allowed. Inspectors are instructed to require batches which are not of the proper consistency or have not been mixed the full time required, to be dumped outside of the forms and not allowed in the work.

The use of proper materials will be required in all parts of the construction of the highway. Any deviation from the standard requirements will be made in the specifications, and not on the job. To prevent delays, and to secure the quality of the materials required, the State Highway Commission will place inspectors at the point of production of all the major materials entering into the construction whenever practicable. This will include Portland and bituminous cement, stone, reinforcing steel, sand, gravel, creosoted timber, and concrete pipe. This method should allow the materials to be received, unloaded, and placed without delay on account of awaiting the necessary test results, provided suitable methods are used by the contractor in handling them, and secure a standard and uniform product for all classes of work.

The specifications for reinforced concrete pipe require more reinforcement than formerly; a change in the proportions of the mixture; and a thicker shell. It is also required that each manufacturer have a suitable machine for testing his product. Very little trouble is anticipated in securing reinforced concrete pipe from established manufacturers, to meet these requirements and the use of reinforced concrete pipe from other sources will not be allowed on State work.

The pipe from each plant will be subjected to periodical inspection and testing by representatives of the State Highway Commission and will be on the approved list without further question as long as these tests show that the pipe conforms to the specifications. The failure of pipe from a given plant to pass these tests will prohibit the use of the product from that particular plant until the stock on hand is exhausted and a new supply available for test and acceptance.

Portland and bituminous cement will be tested and sealed at the time of shipment and, provided it is received in good condition, sealed as reported to the resident engineer, it can be used immediately by the contractor.

Stone quarry inspection will be provided to obtain properly graded aggregate, and efforts will be made to standardize the handling of this material as much as possible, in order to reduce segregation.

Any sand plant which produces a variable product will be subjected to plant inspection so that the contractor will not be held up awaiting test results of material received. One addition to the specifications for fine aggregate is the ''stockpile'' clause. This clause requires that all local sands be stockpiled in not less than two hundred cubic yard units and sufficient supply be kept in advance to allow test results to be available before it is used. This clause will not be enforced where it is considered practicable by the engineer to obtain representative samples from the local pit, but is pri-

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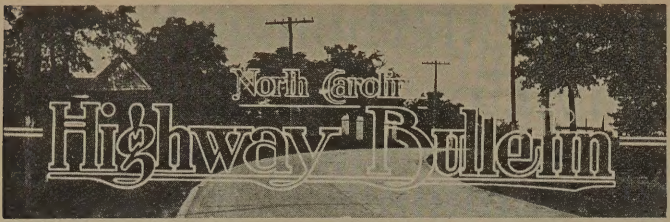

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Address all communications in regard to BULLETIN to the Editor, Box 1140, Raleigh, N. C.

This BULLETIN will be sent gratis to any State or county official, contractor, newspaper, trade publication, library, or other person interested in the improvement of roads and in the work of the Commission. Advertising rates may be obtained on application.

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Editorials

The new Specifications governing State highway construction in North Carolina have recently been issued and should be in the hands of contractors prior to the publication of this Bulletin. In the future proposal sheets only will be mailed to prospective bidders instead of complete specifications as heretofore. Contractors who have not secured a copy of the new specifications should do so at once as all work in the future will be governed by the revised standards. Some of the salient features of the new specifications are discussed in a brief way on page 5.

Contractors who intend using the hand finish method on concrete roads should secure a print of the sheet of adopted standards governing the construction of hand finished equipment. This sheet may be obtained by addressing Geo. F. Syme, Supervising Engineer, Raleigh, N. C.

During the first part of the year the State Highway Commission set as its goal for 1922 one thousand miles of roadwork to be placed under contract. Lettings during the first two months of 1922 totalled approximately 235 miles divided as follows: Sand clay, topsoil, and gravel, 125 miles; Macadam, including all types, 28 miles; concrete, plain and reinforced, 30 miles; asphaltic concrete, 52 miles. More mileage was awarded during February than was let any month since the Commission began to function. As will be seen by figures on page 19 the cost of work under contract or under construction has passed the $20,000,000 mark.

Assistant Engineer W. E. Hawkins, has written a very interesting paper on ''Developments in the Construction of Concrete Roads.'' This article which will be found on page 8 contains good information and should be read by all who are interested in this type of road. The illustrations were made from photos taken on project No. 388, Robeson County.

''Recent developments in road construction'' is discussed on page 11 by Chief Engineer Upham and contains a number of points brought out during the past year in road construction.

Contracts Let February 24th

Previous lettings of highway work were eclipsed by the letting held February 24th when 231 bids were received on the twenty-two projects advertised for letting on that date. Proposals covering the work were mailed out to over 400 contractors and other interested parties. The bids received on the work showed a decline in the cost of roadwork and all of the projects, with one exception, were rewarded. The results of the letting were as follows:

DISTRICT NO. 1

Von Glahn & Talbott, of Spartanburg, S. C., were awarded project No. 140, a bridge in Halifax County on the road between Scotland Neck and Tarboro, their bid being $9,584.26.

Project No. 154, Martin County, was let to the Southern Willite Paving Co., of Richmond, Va., while the structures on the same project were awarded to O. F. Leighton, Inc., also of Richmond. This project consists of 11.27 miles of road between Williamston and the Beaufort County line, toward Washington, and will be surfaced with asphaltic concrete, laid on a cement concrete base at an approximate cost of $394,000.00.

Project No. 166, a bridge between Jackson and Rich Square will be built by the W. D. Murray-Sadler Corporation, of Norfolk, Va., at a cost of $18,000.00 including the grading of 0.47 miles of approaches.

W. N. Thompson, of Burlington, and Nello L. Teer, of Durham, were awarded the roadway and structures respectively on project No. 196, Washington County. This is a section 14.93 miles long of the road between the Martin County line and Creswell and will be graded and surfaced with sand clay at an approximate cost of $82,000.00.

DISTRICT NO. 2

The paving on project No. 210, Craven County, was awarded to the Union Paving Company, of Philadelphia and the structures to A. P. Gilbert, of Durham. The project is located between the Lenoir County line and Fort Barnwell, a distance of 8.34 miles, and will be paved with asphaltic concrete on a cement concrete base at an approximate cost of $288,000.00, this including both roadway and structures.

R. E. Martin, of Mountain City, Tenn., was awarded the contract for grading 16.47 miles of road between Delway and the Pender County line, Sampson County, and Striblin, Stauddy, and Newell, of Corinth, Miss., the structures on the same project, designated as No. 272. The cost of the work will be in round figures $99,000.00.

DISTRICT NO. 3

Twelve miles of the road between Elizabethtown and Clarkton, Bladen County, will be graded and surfaced with sand clay by T. W. Chandler of Virgilina, Va., and the structures built by Nello L. Teer, of Durham; the total cost of the project, No. 300, being $65,178.90.

Project No 377, a bridge near Wallace, on the Pender-Duplin County line will be built by the Hazell-Connerat-Quist Construction Co., of Macon, Ga., and the approaches graded by R. E. Martin, at a cost of $77,000.00.

DISTRICT NO. 4

R. M. Walker & Co., of Atlanta, Ga. will build a reinforced concrete bridge over the Haw River in Chatham County for approximately $57,400.00. This project, No. 400, is located on the road between Pittsboro and Chapel Hill.

DISTRICT NO. 5

Project No. 538, a small bridge near High Point, Guilford County, was awarded to J. L. Brinkley, of Thomasville for approximately $6,900.00.

The Gibson Construction Co., of Knoxville, Tenn. will build project No. 566, 7.14 miles of topsoil road between Aberdeen and the Richmond County Line and Nello L. Teer of Durham the structures, the total construction cost being $61,380.60.

Project No. 567, a short stretch of road between Aberdeen and the Hoke County line will be graded and surfaced with topsoil by C. E. Teague of Augusta, Ga., for $7,690.43 for the 2.96 miles included.

Project No. 577, the only hard surfaced job awarded from the Fifth District was let to the Royer-Ferguson Co., Inc., of High Point, also contractors on the High Point-Winston-Salem road. A plain concrete pavement will be laid and with the structures, which were awarded to J. L. Brinkley, of Thomasville, will cost approximately $411,376.00. The project is a part of the High Point-Randleman Highway and is 13.37 miles in length.

DISTRICT NO. 6

Geer & Wilson, of Rutherfordton, will grade and surface with topsoil 6.39 miles of road in Anson County, between the Stanly-Anson line and Wadesboro while the structures on the same project, No. 607, were awarded to Booz-Lloyd & Co., of Marion. The total cost of construction is estimated to be $40,517.29.

The second link of the Mecklenburg County section of the Charlotte-Statesville Highway, project No. 654, will be built by Lampton and Burks, of Louisville, Kentucky for approximately $303,000.00 for the 10.1 miles included. The project is located between Huntersville and the Iredell County line, lying between two sections of the highway already under construction. The standard type of asphaltic concrete surface on a cement concrete base will be laid.

(Continued on page 13)

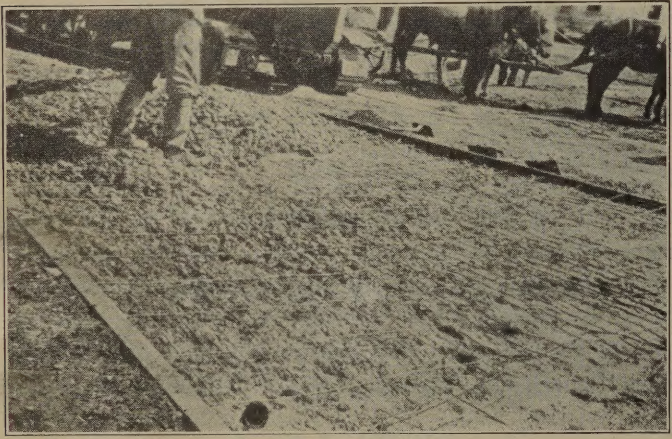
Developments *in the* Construction *of* Concrete Roads

By W. E. Hawkins, *Asst. Engineer, State Highway Commission, Raleigh, N. C.*

IN the consideration of permanent roads we have been passing thru an age of transition regarding methods of construction for the past fifteen years. The public have now begun to realize what a good road means, with the result that large sums of money are being appropriated for the construction of better and permanent roads. North Carolina, being one of the foremost States in the Union, has followed the lead of other States and ten months ago launched out upon an ambitious good roads construction program.

Engineers have been striving for years to develop and construct a permanent road, a road that would be giving the public their money's worth, that, with proper maintenance would still be in existence upon the maturity of the bonds, and one that would satisfy the requirements of the public.

Various types and kinds of construction have been made the subject of experiment until at present time a concrete roadway is one of the recommended pavements in all localities.



By Using Reinforcement In Concrete Roads the Thickness of the Pavement May be Reduced.

Approximately ten years ago, concrete received its first impetus in roadway construction. With the increase of motor driven vehicles it was found that further construction of macadam roads with their excessive maintenance costs was a waste of money. With this realization several States built sections of concrete roads where traffic was heavy. The question of strength and wearing surface at first was not given proper consideration, with the result, that failures occurred in a very short time. With the increase in traffic the riding surface of the pavement gave way to rough and uneven places, and as the strength of the pavement was not sufficient to withstand the ever increasing load, nuemrous cracks occurred at different points in the pavement.

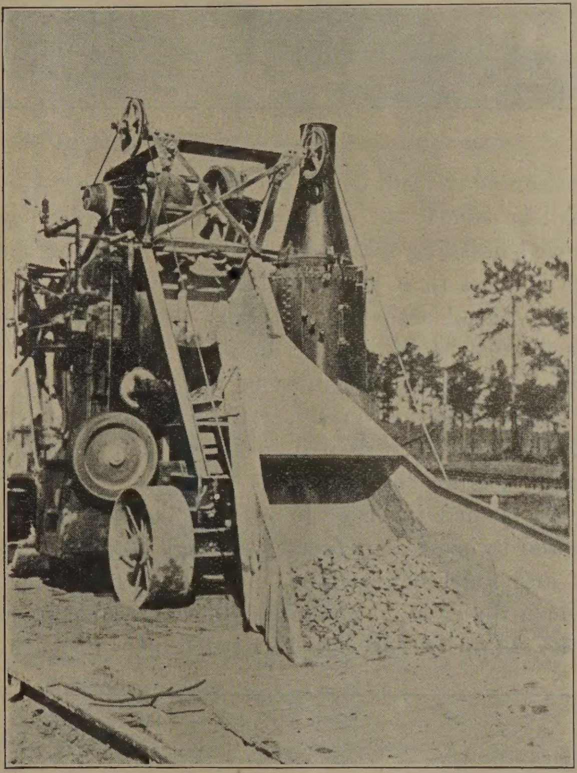
In the past, failures of concrete pavements have been attributed to improperly prepared subgrades; inadequate drainage systems; the use of aggregates which were not clean, well graded or properly proportioned; the use of cement that had not been properly tested or stored on the job; inadequate or irregular mixing, the use of too much water, and a scarcity of cement. In many cases the pavements were not built to specified depth, and the reinforcing material was not placed as specified. Failure also resulted when poor finishing methods were employed or when the curing was not carried out according to specifications. The subgrade must be uniform; well drained at all times; soft or wet spots must be removed; free from any objectionable material; have no ruts, bumps or low places; and firm and well rolled. It is a waste of money to lay a concrete road upon a subgrade that is not properly prepared, as in due time, failure of that section of pavement will surely result.

After the subgrade has been properly prepared, forms should be erected according to alignment and grade as given by the engineer. The riding qualities of a concrete road depend to a large extent upon the forms. Wood forms have shown by experience to be unsatisfactory, as they soon become warped, split and broken. Steel forms weighing about four pounds to foot were at first used, but constant use, coupled with careless handling, caused poor alignment, grade and finish. This weight has been increased from time to time until experience has demonstrated that with each increase of form weight, better results have been obtained in surface finish and riding qualities. Forms must be oiled or greased each time before use. At all times they must be set accurately, with good alignment, grade and stability. Poor line, grade and insufficient staking will result in uneven and rough riding surfaces. Two hundred feet of forms on both sides must be set at all times in advance of the mixer in order to insure proper alignment and grade.

The materials entering into the construction of the road should be first class in quality, as they are the vital parts of the pavement. All materials must pass a rigid laboratory test before being used. This is especially true of the fine aggregate, as poor quality in this material in the past, has been responsible for many failures in concrete pavements.

Cement should be sampled from cars when loading at the mill. The cement must be carefully stored and kept dry. Under no condition should it be placed on the ground. When cement that has not been tested arrives at the work, it should not be unloaded until sampled. Until a report has been received the cement should be carefully stored in a shed, and so placed, that it can easily be identified in case of necessity. All materials used must be well graded, clean, tested and approved by Engineer of Tests before being used in the work.

In regard to the strength and section of concrete pavements, we have two types, a road with a flat subgrade, 6 to 8 inches thick at sides and 8 to 10 inches thick in the center. This design has been found to possess sufficient strength and endurance to take care of our future traffic needs. The other type is a pavement of uniform thickness with fabric reinforcement placed two inches from the surface which in some cases will prevent cracking while in others will prevent cracks from opening up. This reinforcement also gives pavement sufficient beam strength to counteract any tranverse and longitudinal cracks which would have eventually developed had the pavement not been reinforced. With our present design of fabric reinforcement with marginal bars at the sides of the pavement, a road of 6 inch uniform thickness, so reinforced, will certainly prove durable and suitable to the traffic needs of this State.



THE MATERIALS SHOULD BE THOROUGHLY MIXED IN A STANDARD TYPE OF MIXER

Poorly proportioned and weak batches in a day's run result, after a few years service in pot holes, and surface disintegration, which affect riding qualities of road and require maintenance.

The Inspector should keep an accurate check on the amount of cement used, maintain a daily record of length of pavement laid, and report daily, to the Raleigh Office and District Engineer, the quantities of cement used.

There are three methods now being almost universally used in the mixing and placing of concrete roads. First, the central proportioning plant, where the aggregates are proportioned at a central plant, in measuring boxes, loaded into batch boxes, and hauled by trucks or industrial railway to point of use. Second, central mixing plant, concrete being prepared at central plant and hauled to point of use by motor truck for distances of several miles. Third, materials being distributed along project adjacent to road in storage piles at distances of from 500 to 1000 feet and hauled in carts or trucks, with proportioned compartments, to point of use.

SHOWING THE SUBGRADE TEMPLATE IN FOREGROUND. BACKGROUND—PLACING FABRIC REINFORCEMENT

SPREADING TOP COURSE OF CONCRETE AND STRIKING-OFF WITH HAND TEMPLATE TO INSURE PROPER CROWN AND DEPTH.

Under no consideration should materials be allowed to be dumped upon the subgrade. Experience in the past, with this method, has demonstrated that the subgrade has not been properly prepared before materials are placed thereon; and wheel-barrows as measuring devices have not given satisfaction. Aggregates shoveled or forked with this method become mixed with dirt and other objectionable material.

The correct measuring of all materials insures satisfactory work. The contents of all proportioning boxes, batch boxes or other measuring devices must be determined by accurate measurements.

The next important step is the mixing of the materials. They should be mixed for 1½ minutes in a batch mixer equipped with a timing device attachment. Water should be added at the time the materials are being run into the mixer. In the mixing of concrete, the time of mix and the water factor are most important. As a general rule the less water used and the greater the time of mixing, the stronger the concrete as a result. A concrete of proper consistency can be obtained with less water if the time of mixing is increased. Many thousands of dollars are wasted by the use of too much water during mixing. It is obvious that a larger amount of water will allow a mixer to turnout what looks like a well mixed concrete but in such cases we do not get proper hydration of the cement and the plasticity, which is so necessary for strong concrete. The concrete should come from the mixer with every particle of the fine and coarse aggregate coated with cement; when deposited it will be neither sloppy nor granular but of a workable consistency which when placed will form a compact and uniform mass.

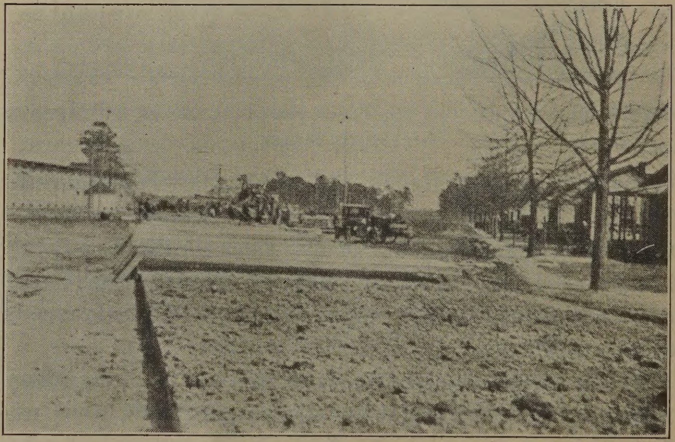
Before placing concrete subgrade should be tested with a subgrade tester to insure proper depth of pavement. The subgrade must be firm, smooth and uniform. Concrete shall be placed only on a moist subgrade and by means of a discharging device which does not cause separation of matrix and the course aggregate. If concrete is too wet the mortar will separate, leaving the coarse aggregate pocketed. This results in concrete which is weak in spots. The use of short handle square point shovels allows the laborers to deposit the concrete in a uniform mass more so than the use of any other implement.

ROLLING THE PAVEMENT TO COMPACT AND GIVE SMOOTH SURFACE.

If fabric reinforcement is used, it must be perfectly flat when placed in the work. If finished in rolls it must be flattened by the use of a machine. The fabric must extend to within 2 inches of the sides of the pavement, and must be lapped ½ the distance of the spacing of the main members. If the reinforcement is placed lower than 2 inches in the pavement, the desired result is lost. A striking template insuring a 2 inch depth must be used in order to secure uniformity. The first layer of concrete shall be deposited to the depth of fabric reinforcing and then struck off with approved template. After reinforcement is in position, the remaining 2 inches of concrete is placed on top of it. Workmen should not be permitted to walk in the concrete after the initial spreading.

USING THE BOW-BELT TO GIVE FINAL FINISH.

As soon as the full depth of concrete has been spread, it shall be struck off, either by a hand template or an approved finishing machine. The hand template should weigh not less than 400 pounds, and be shaped to cross section of road according to plans. A slight excess of concrete must be maintained ahead of the strikeboard at all times. The template must be worked in a cross wise and longitudinal movement, always keeping an excess of concrete ahead; this will insure a uniform and true surface. Before the pavement is struck off, the sides must be spaded in order to prevent honey-combed sections and to insure satisfactory edging. Templates, both hand and finishing machine, must be checked morning and noon for crown. Sufficient allowance must be made for the slump of concrete in hardening. They should have a crown of at least ¼ of an inch greater than crown of finished pavement.



AFTER ROLLING PROCESS IS COMPLETED THE SURFACE SHOULD BE COVERED BY CANVAS AND AFTER 24 HOURS WITH A LAYER OF DIRT WHICH SHOULD BE KEPT WET.

(Continued on page 14)

Recent Developments *in* Road Construction

Chas. M. Upham, *State Highway Engineer.*

Half-Width Roads.—The construction of half-width roads can hardly be called recent. It has been found that this method may be followed and satisfactory results obtained. This development of road construction releases the traffic from the long rough detours, which are very often present in road construction, and makes the road available for traffic during construction.

This method has been utilized satisfactorily in the case of the construction of the bituminous type pavements, and, in a few instances, it has brought about good results in the construction of water-bound macadam, but it is generally used in concrete road construction.

Where this road is constructed for a heavy duty road, it is very often heavily reinforced, and each half of the road is kept separate and apart from the other half, so that the complete pavement really consists of two strips of pavement laid side by side. In this method of construction the heavy reinforcement is longitudinal, and, on account of the center line joint taking up the vertical movement of the pavement, thus eliminating any longitudinal cracking, and the transverse cracking is decreased to a minimum, even in the part of the country that is subjected to heavy frost.

In other instances tie rods have been used to tie the two strips of pavement together. This method, however, introduces difficult details in construction, and at the present time has shown no particular advantage over the other. The practical advantage of the longitudinal joint is in the fact that the construction joint is easily maintained, and is not especially objectionable in appearance, while a jagged, irregular longitudinal crack is difficult to maintain, and is very unsightly in appearance.

In some states this longitudinal or center line construction joint is provided, even though the pavement is constructed in one operation, the advantage being the same as when the pavement is constructed in two sections.

Widening Old Macadam.—Another recent development is the widening out and the reclaiming of old macadam roads by building a strip of hard surface pavement on each side of the macadam. On either side of the old macadam road varying from 5 to 10 ft. in width, there is placed a strip of concrete pavement from 9 to 10 ft. wide; these strips being sometimes reinforced. This method furnishes a comparatively wide pavement, and renders useful a road which would otherwise be too narrow to be of any service to traffic.

Increasing Amount of Reinforcement in Concrete Roads.—Another development in road surfacing has been the general tendency to increase the amount of reinforcement in concrete roads.

Only a short time ago many engineers were reinforcing their roads with metal wiring, approximately 25 to 27 lbs. to 100 sq. ft. At the present time it is a common practice to use approximately three times this amount, with the tendency to still further increase the weight of material. The Specifications of North Carolina for 1922 will undoubtedly call for metal amounting to nearly 100 lbs. for each 100 sq. ft.

This has effected a large economical advantage in the cost of roads, which has brought a reinforced concrete surface to the point where the changes in reinforcements are not left to the imagination. The present price of steel has made it possible to create considerable saving in dollars by the construction of thinner concrete pavements. Where reinforcement has been used in most cases the road has been constructed of a universal thickness, this also affording a considerable saving of concrete.

Batch Transfer and Central Mixing.—Much progress has been made in the methods of laying concrete pavements, the tendency being not to allow concrete materials to be placed on the subgrade. The batch transfer method is now becoming a standard form of construction. This method has proven economical, in most instances, and capable of large yardage.

There have been many combinations of this method, such as hauling by industrial railway with the batch boxes carried upon the railway cars; as well as the motor truck hauling with the batch boxes loaded on the trucks; and the trucks being provided with batch compartments. In some instances the batches have been hauled a portion of the distance by trucks and transferred to industrial railway. This has proven a very economical combination in many cases.

The central mixing plant for concrete pavements is now commending itself on many projects. In most cases the ready-mixed concrete is hauled to the construction by means of trucks. The only detail in this method which can be considered questionable at this time, is the transferring of the concrete from the trucks. It is possible in many cases that there is a segregation of aggregates and, no doubt, this detail must be overcome, but this method of construction is bound to gain in popularity from year to year.

In a few instances engineers are calling for a piece of bituminous surface road to be constructed on 1:2:4 concrete and requiring that the concrete base be properly cured, as called for in concrete surface, for a period of at least two weeks.

Covering Green Concrete Pavements.—For a long time the curing of concrete pavements has been neglected, and it is only recently that this detail of construction has been given the proper attention. One of the most important developments which has been brought about recently is the use of the burlap covering in the early curing of concrete surface.

The finished pavement is covered with strips of burlap, approximately 4 ft. in width, and extending the entire width of the pavement. This burlap is kept wet and then placed on the finished concrete surface from

(Continued on next page)

about 10 to 20 ft. back of the finishing operation. The slight marking of the surface from the burlap is negligible.

The burlap should never be allowed to dry out and thus the concrete does not lack the necessary water for hydrating in the early periods, a condition which has often existed in the other methods of curing concrete roads.

I consider that this is one of the greatest developments of details, and one which has actually improved the lasting quality of concrete. As soon as the road surface becomes hardened the burlap is rolled up and ready for the next day's work, while the concrete road surface is covered with earth, sprinkled and wet in the usual manner.

Riding Qualities of New Road.—Many spcifications are now including regulations as to the riding qualities and evenness of the concrete road surface. Ordinarily this cannot be tested until the next day when the concrete has hardened sufficiently to bear one's weight. Recently there has been an appliance invented which consists of an extremely light straight edge, which may be fastened to the end of two handles in order to reach out to the road surface and test the surface before it has become hardened.

Curing Concrete Pavements.—Many other experiments have been carried out in the detail of curing concrete pavements, but no definite results have been obtained. One state has used calcium chloride in solution applied on approximately 1 in. of earth covering. Another method tried has been the covering of the concrete surface with a heavy asphaltic oil. The oil was applied to the road in the proportion of about 6/10 gal. per sq. yd., and in two weeks' curing period the asphalt was peeled off and again used. No definite recommendation is made at the present time in regard to this method.

Another extraordinary experiment has consisted of the oiling of the subgrade preparatory to the laying of the concrete pavement, the object being to prevent mud during the light showers. It has been found that when the light truck is used this oiling proves to be a considerable advantage, and, no doubt, the oil offers some assistance to the stabilization of the subgrade.

Steel Bar Reinforcement.—While for a long time it has been customary to use wire fabric in the reinforcement of concrete highways, steel bars are occasionally used, and while there has been no development in regard to the use of this fabric reinforcement, there is, however, a change in the method of using steel bars. The new development consists of making these bars into a mat, consisting approximately of 10 to 14 bars transversely, and about 5 bars longitudinally. The mat is then wired together and handled as sheet reinforcement.

The use of dowels at the transverse construction joint can hardly be considered as new, as this method has been carried on for several years, and found to be very satisfactory in overcoming the tendency of one slab to rise above the other.

Another method in construction detail is the installation of fibre conduits placed transversely across the road at various intervals, especially through small towns and villages. It is the function of these conduits to provide a means for gas, water and electric wiring to cross the road without making it necessary to break up the pavement.

Bituminous and Brick Developments.—In the construction of sheet asphalt surfaces there is a tendency to be more liberal in the grading of sand aggregates, and the use of a lower penetration asphalt. There is also an inclination to use a 3-wheel roller in compacting the sheet asphalt surface. While this is not absolutely new, its use has never been universal.

Another new development is in the combining of a binder course and sheet asphalt surface in the one course, which virtually consists of a stone-filled sheet asphalt, the stone composing from 25 to 60 per cent of the entire surface. When this surface is used no binder course is laid, and the surface is compacted as an ordinary asphaltic concrete.

Recent developments in brick pavements have shown that the vertical fibre brick laid on a concrete base and sand cushion, grouted with a bituminous material is capable of withstanding the ravages of traffic.

"Progressive Type" of Road in North Carolina.—The findings of the Subgrade Committee, of which Senator du Pont is chairman, have shown that the traffic-bearing properties of the pavement depend greatly upon the stability of the subgrades, and that the subgrade can be greatly stabilized by being mixed or covered with a non-capillary material, such as sand, gravel or top soil. This has led to the development of what, in North Carolina, has been termed the "Progressive Type" road, which consists, first, of the grading of the road and the building of drainage structures, and then surfacing with a non-capillary material, such as gravel, sand, clay or top soil, which, in truth, is nothing more than the construction of a subgrade highway for a future constructed hard surface pavement. This can be maintained as a subgrade highway for medium traffic at a reasonable cost, and, when occasion demands, it can serve as a high bearing value subgrade for any type of surface desired. This method of construction means that all previous steps in the construction have been preserved and that the completion of a hard surface road is merely an addition; there being no economic loss whatever, due to the fact that the previous work is incorporated into the completed hard surface road.

Waterproofing Sand-Clay on Top Soil Roads.—I would not consider this paper complete without describing one of the new methods we are trying, and which promises to be very satisfactory in the treatment of constructed subgrade highways, now being utilized as roads, and in the treatment of top soil or sand-clay roads. Many states are situated similarily to North Carolina to the extent of having a large mileage of sand-clay top soil, or gravel surfaces.

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Road Building *in* United States *with* Federal Aid

SOME intensely interesting figures have just been given out from Washington relative to roads built, under construction and under agreement for construction throughout the United States in conjunction with federal aid funds. These funds were distributed among the several states by the bureau of public roads, United States department of agriculture, since July 1, 1916. The report shows that federal aid roads under the above three headings total 281,135 miles.

What will be of particular interest at this time is not so much the number of miles built, but the average cost per mile for the different parts of the work. This is true by reason that in some sections there has been a concerted movement for the abandonment of permanent highway building because of the excessive cost. A study of the government report will indicate whether or not the different localities have been paying too much for paved roads.

The department's summary by types shows the following mileage:

Material	*Miles*
Graded and drained	8,864.0
Sand-clay	2,695.5
Gravel	10,042.5
Macadam (water-bound)	1,290.7
Macadam (bituminous)	1,823.2
Bituminous concrete	772.5
Concrete	4,653.0
Brick	44.6

In addition to the foregoing, bridges with their approaches to the total length of 47.4 miles were constructed or are now under agreement for construction with federal aid and state funds combined.

The table shows a large mileage of graded and drained, sand-clay, gravel, and macadam roads, while there is less mileage of concrete, bituminous concrete, and brick roads. This situation is due to the increased cost of construction for the higher types of roads. The average cost figures per mile of the different grades built during the 4-year period, or now provided for, are as follows:

Material	*Cost*
Graded and drained	$ 8,115
Sand-clay	8,250
Gravel	10,400
Macadam (water-bound)	17,320
Macadam (bituminous)	21,300
Bituminous concrete	30,350
Concrete	39.540
Brick	49,570

The total cost of the 28,135 miles of roadway is $496,151,683.43; the average cost per mile, $17,630. Of the total cost the sum of $211,135,376.31 was made available through federal aid the remainder through the states. This is at the average rate of $7,500 per mile of federal aid funds, for the total mileage built.

Contracts Let February 24th

(Continued from page 7)

DISTRICT NO. 7

Project No. 731, Davie County, was awarded to G. R. Martin, of Salisbury, and to Heilig and Sherrill, of Winston-Salem, the former the roadway and the latter the structures. The project is located between Mocksville and Winston-Salem, is 5.46 miles in length, and will be surfaced with plain concrete at an approximate cost of $195,000.00.

DISTRICT NO. 8

The bridges and culverts on project No. 855, Mitchell County, were awarded to the Luten Bridge Co., of Knoxville, for approximately $7,450.00. The roadwork was previously let to the Fiske-Carter Construction Co., and has been under construction for sometime past.

Waterbound macadam will be used to surface 5.58 miles of road in Mitchell County, between Ledger and Bakersville. The roadway on the project which is designated as No. 860 was let to the J. F. Mulligan Construction Co., of North Wilkesboro, and the structures to the W. H. Anderson Construction Co., of Spruce Pine, the total construction cost being $153,000.00.

DISTRICT NO. 9

Project No. 904, one of the shortest projects awarded had a large number of bidders. The work consists of paving 1.6 miles of road between Grace and New Bridge, Buncombe County. The Asheville Paving Company was finally awarded the roadwork and paving with asphaltic concrete, while R. C. Stevens, also of Asheville, was awarded the structures, the entire cost being $81,079.35.

Project No. 940, Haywood County, was let to Alexander and Patton, of Swannanoa, and to H. A. Brown & Co., of West Asheville. The project will be surfaced with waterbound macadam and will cost in round figures $126,000.00 for 7.13 miles.

Developments *in the* Construction *of* Concrete Roads

(Continued from page 10)

After the concrete has been struck off, it should be rolled with a roller of size and weight according to specifications. This removes all air-bubbles and pockets in the concrete. The use of the roller must not be delayed until the surface is partially set. Too early rolling will remove too much mortar and not water. The roller must be moved slowly, passing over surface and back, it is then lifted and advanced ½ its length, the rolling operation then being repeated. Free water must be allowed to come to the surface between each rolling, and the rolling continued until this ceases. The roller must be wetted after each operation and kept clean and true in form.

After final rolling the belting of the surface should follow. The belt must be kept moist or oiled and cleaned at all times. It should be made of a composition and size according to specifications. The first belting of the surface takes out small irregularities, removes excess water and smoothes the surface. It is necessary to repeat this operation to secure the desired results. The final belting must be given the surface when concrete has partially set, all excess water having been taken off and the finished surface resulting should be uniform and of gritty texture. The belt should not be allowed to rest on the fresh concrete at any time.

In the use of the finishing machine, poor results have been obtained in the past, because of inexperienced operators. An operator must be experienced,or instructed and trained to finish a pavement which is uniform. The defect of finishing machine work is an irregular wavy surface, which is caused in a number of ways. These can be remedied by not allowing machine to move too fast, keeping excess of material in front of strikeboard and a proper amount of tamping. The tendency in the past, has been to finish the surface entirely too wet, in machine finish. To overcome this, the surface should be required in all cases to be rolled with a hand roller as hereinbefore described under hand finishing.

The placing of transverse joints in a concrete pavement has had a number of years of experiment. Some engineers are still placing joints at from 25 to 40 feet apart unreinforced, with a joint filler. It has been demonstrated that the best results will be obtained by placing joints reinforced with dowel rods at the end of each day's work, with joint filler of from ½ to 1 inch; this will allow free movement as the slab expands or contracts.

The last operation of a concrete pavement is that of curing. The best method of curing is obtained by ponding. Tests have shown that additional strength and better wearing qualities have been obtained by proper protection and curing of concrete. As soon as the surface of the concrete is finished, it should be protected by canvas or other similar material, placed on frames or on the surface of the pavement. Another practical method is that of placing burlap on the surface of the concrete as soon as it has sufficiently set to bear same, without marring the surface finish. This is kept wet continually during the day's run, and removed next morning, when the surface should be covered with 2 inches of earth and kept wet continually for next two weeks. Hair checking or cracking can sometimes be eliminated by the use of the wet burlap, placed on the surface. If this does not prevent it, then coarse and fine aggregate should be sprinkled before being placed in the mixer. The pavement, after receiving earth covering should be kept wet or soaked for 14 days, and under no consideration should traffic be permitted on the pavement within less than 21 days.

Before traffic is allowed on the pavement, all joints and cracks should be sealed with tar or asphalt. Applications should be poured flush with openings, in narrow widths and straight lines. Material should only extend 1 inch on each side of joint or crack; after application, material should be covered with coarse sand.

It is very important that water be kept from penetrating to the subgrade. Shoulders should be built adjacent to the pavement in accordance with plans in a reasonable time. They should be built of such material, and on a slope, that will allow water to flow quickly away from the pavement, and be sufficiently firm to protect the edges. In order to insure a long life road, side ditches having a minimum depth of 9 inches below bottom of pavement should be constructed throughout the entire length of pavement, and small outlet trenches or drains in the shoulders should be built on grades, and at all low points in vertical curves at break of grade to prevent moisture from seeping under the pavement. If foundation is not properly drained, cracks will eventually occur in surface, which will cause failure of the pavement in time.

Careful and competent inspection should be applied at all times during period of construction. The idea of inspection is not to cause annoyance or arguments with the contractor, but to help him get the best results possible by watching careless employees and guard against faulty methods and the use of materials that would be detrimental to the work. Careful surveys may be made, and specifications and plans carefully prepared, after the most thorough investigation and study of conditions. The best material may be used, and without the proper combination of materials, and careful workmanship at all times, along with continual careful inspection, the work may prove to be a failure in due time.

The specifications should be thoroughly familiarized, in fact, they should be memorized in order that any doubt arising from time to time in regard to the various phases of the work can readily be dispelled. Every operation in the construction of a concrete pavement is an important one, therefore attention should be given to all the details of construction. These many details are never too small, for the moment that we become lax, a failure in the pavement will surely result. It is our aim to get the best and smoothest riding pavement possible and this we have not as yet attained. The design and construction of concrete roads is still passing thru an age of transition. It still demands a great deal of study, and in order to get the maximum results from our efforts, with a minimum of expenditure we must follow first class methods in construction.

Standardization *of* Materials *and* Methods *in* N. C. State Highway Construction

(Continued from page 5)

marily to control the use of creek and bank sands which might vary greatly in quality as the supply is worked. A cement adjustment is to be made whenever possible to allow fine aggregate, which might not pass the requirements in itself, to be used provided a concrete of standard quality can be obtained by the use of additional cement. While at present this adjustment is based on the standard sand test it is proposed to test concrete made with these sands as soon as the new concrete laboratory of the State Highway Commission is completed.

A change from the requirements that fine aggregate be from seventy five to one hundred per cent strength of standard Ottawa sand for various classes of concrete, in the old specifications, to one hundred per cent for all classes of concrete will be effective in the new specifications. The use of suitable stone screenings as a substitute for sand to an extent not to exceed fifty per cent of the fine aggregate, will be permitted.

It is the intent of the State Highway Commission to give rigid but intelligent inspection and to require only what is intended by the specifications. The methods used in the construction of the hard surfaced roads will be standardized as much as possible and will be in direct charge of the resident engineers and inspectors. The State Highway Commission has trained men for bituminous paving plant and road supervision and will furnish inspectors for portland cement concrete roadway construction, who have been trained, by experienced men, for this work. This training will serve to make inspectors available for the great amount of work to be carried on and will not cause the contractor inconvenience on account of having an inspector who is not familiar with the standards and methods required. A chief inspector will be available for the purpose of instructing roadway inspectors in the proper performance of their duties, and will be present on any project upon which methods are being used which do not conform to those approved. Two construction engineers each for bituminous paving and portland cement concrete paving will spend their entire time in the field to assist each District Engineer in his work.

Accurate records of all hard surfaced work will be kept in the office of the State Highway Commission at Raleigh and copies will be forwarded to the District Engineers who have the work under their immediate jurisdiction. These records will consist of the amounts of materials received, the use to which these materials was put and a detail progress record of the roadway on each project. For this purpose, each inspector is required to send in a full report each day to the Raleigh office, and each resident engineer reports monthly.

With intelligent inspection and enforcement of the details of the specifications and a standardization of methods and materials, a better basis is furnished the contractor upon which he can make an intelligent bid and cooperate with the engineer to secure the high grade pavement required. He should not be handicapped by uncertainties and misunderstandings regarding the specifications.

Recent Developments *in* Road Construction

(Continued from page 12)

There has been much experimenting in the attempt to secure a bituminous material which would satisfactorily preserve this type of road surface. It was generally found that any bituminous material sufficiently light to penetrate this surface would have practically no binding qualities, and that any bituminous material sufficiently heavy to have binding qualities would form a mat on the top of the road surface, and soon peel off, due to the dusting of the road surface directly underneath the bituminous covering. The weak point in this treatment was not in the bituminous blanket, but in the contact of the bituminous blanket with the road surface.

North Carolina is attempting to develop a method which will correct this weakness, and provide a contact between the bituminous covering and the road surface. The method consists of softening the road surface by means of sprinkling and then rolling into this surface broken stone or gravel of approximately 1½ in. in size. After this has become thoroughly imbedded in the top soil or sand-clay it is allowed to dry out, and subjected to traffic for a short period, after which it is swept clean by brooming.

The road surface now consists of a single layer of crushed stone imbedded in the strong and rigid sand-clay or top soil surface, and forms a satisfactory bond of contact for the bituminous material. Thus a sufficiently heavy material to have binding qualities can be applied to this sand-clay road, and the layer of broken stone will prevent the dusting up of road surface directly underneath the bituminous mat. By waterproofing the top soil or sand-clay in this manner, a strong pavement is preserved and after the first application of the bituminous material a mat can be built by using various types of pavement. While this method has not been in practice long enough to prove its complete success, the developments show that for a slight expenditure a sand-clay or top soil road can be materially improved.

STATUS OF FEDERAL AID WORK IN NORTH CAROLINA

Projects Under Construction

"H S" denotes any type of hard surfaced road.

"G" denotes any type of gravel, sand-clay, or topsoil road.

NO.	COUNTY	LENGTH	TYPE	APPROXIMATECOST	BEGUN	CONTRACTOR
4	Craven	9.46	G	$ 21,089.23	10–12–19	County Commissioners
13	Wayne	12.573	G	101,467.23	5–25–20	County Commissioners
15	Guilford	4.205	H S	5,441.75	9- 1–17	County Commissioners
16	Haywood	14.27	G	64,705.05	7–26–19	County Commissioners
17	Wilkes	17.6	G	101,386.08	10–15–18	County Commissioners
49	Lenoir	6.017	H S	199,872.19	2– 9–20	T. H. Gill & Company—West Construction Co.
53	Lenoir	7.234	H S	246,838.20	7– 6–20	T. H. Gill & Company—West Construction Co.
58	Johnston	6.018	G	69,453.50	5–20–20	P. R. Ashby
60	Lenoir	7.88	H S	259,445.25	12–23–19	T. H. Gill & Company—West Construction Co.
61	New Hanover	2.186	G	234,841.39	7–12–20	C. W. Lacy
66	Haywood	6.18	G	105,296.45	9–15–20	O'Brien Construction Co.
68	Sampson-Harnett	27.4	G	305,225.54	7–23–20	P. R. Ashby—F. L. Grant, Inc.
69	Transylvania	9.348	G	231,409.04	3–25–20	Allport & Alexander Construction Company
70A	Jackson	4.83	G	150,081.11	6–18–20	Wright & Nave
73	Nash	8.73	G	159,913.16	1–20–21	Porter & Boyd
75	Columbus	7.06	G	66,605.38	12– 9–20	County Commissioners
86A	Martin-Bertie	3.09	G	98,454.67	2–25–20	State Forces (Road)
86B	Martin-Bertie	....	Bridges	332,308.83	3–19–21	Boyle-Robertson Construction Co.
90	Pamlico	12.03	G	127,981.78	1– 2–21	Eagle Engineering Company
93	Franklin-Warren	19.8	G	192,993.57	9–25–20	Chandler & Ragland—Stearns Bros.
94A	Mitchell	5.04	H S	190,375.13	6–22–20	Gibson Construction Company
96	Yancey	2.95	G	82,653.12	1– 3–21	Gibson Construction Company
98A	Moore	20.53	G	259,240.38	9–10–20	J. T. Plott—J. E. Lane & Co.
98B	Moore	8.75	G	41,055.46	6– 6–21	Lee J. Smith Construction Co.
99B	Chatham	21·82	G	259,931.59	11–19–20	J. T. Plott—Atlantic Bridge Co. (Bridges)
101B	Randolph	9.64	G	107,928.75	11– 5–20	J. T. Plott—Hanford Bros. (Bridges).
103	Duplin	11.32	G	111,931.05	6–10–20	County Commissioners
117	Wilson	6.25	G	41,828.93	3– 8–21	County Commissioners—Lee J. Smith (Bridges)
120	Bladen	23.67	G	105,688.55	2–16–21	J. A. Marrow—P. R- Ashby (Bridges)
125A	Alleghany	4.99	G	153,899.13	11–22–21	W. E. Graham
127	Wilson	7.63	G	33,780.45	3– 5–21	County Commissioners—Lee J. Smith (Bridges)
136	Davie	6.99	G	61,733.04	2–14–21	Chandler & Ragland—Hagedorn Const. Co.(Bridges

Projects Completed

NO.	COUNTY	LENGTH	TYPE	APPROXIMATECOST	COMPLETED	CONTRACTOR
1*	Mecklenburg	....	Bridge	$ 59,224.90	9– 5–18	C. W. Requarth & Company
2*	Henderson	7.75	G	33,141.74	12–17–19	State Convict Labor
3*	McDowell	2.85	G	24,405.73	12–17–19	County Commissioners
5*	Burke	8.03	G	19,888.05	11– 1–19	County Commissioners
8*	Cumberland	13.46	G	62,800.71	6–20–21	County Commissioners
9*	Polk	12.78	G	68,175.45	4–15–21	County Commissioners
11*	Lenoir	1.78	H S	56,893.18	1–25–21	West Construction Company
12*	Wayne	8.62	G	26,727.98	11– 2–20	County Commissioners
14*	Halifax	8.01	G	19,017.83	8–20–19	State Convict Labor
18*	Alexander	9.8	G	66,446.49	3–31–21	County Commissioners
19*	Rockingham	8.21	G	32,759.36	11–11–19	County Commissioners
20*	Yadkin	6.41	G	25,146.45	7–26–20	County Commissioners
21*	Person	7.675	G	25,911.04	3–15–20	County Commissioners
22A*	Alamance	1.196	H S	30,103.48	6–27–19	County Commissioners
22B*	Alamance	8.3	H S	290,179.36	8–19–21	Powell Paving and Construction Company
23*	Burke	7.68	G	42,873.90	11– 1–20	Lovelady Township Forces
24*	Wake	4.24	H S	127,840.21	11–30–19	W. W. Boxley & Company
25*	Person	8.175	G	101,537.51	10–20–20	County Commissioners
26*	Davidson	8.41	G	14,115.96	10– 1–19	County Commissioners
27A	Orange	8.235	G	53,945.73	4–23–21	W. S. & L. A. Crawford
29*	Union	8.655	G	58,949.25	4– 8–21	County Commissioners—J. S. Stearns
30	Mecklenburg	6.304	H S	102,551.35	3–31–21	County Commissioners
31*	Buncombe	3.1	H S	70,174.88	10–24–19	County Commissioners
33	Montgomery	3.72	G	15,246.71	6– 8–21	County Commissioners
34	Wayne	....	Bridge	50,798.00	10– 8–21	Roanoke Bridge and Iron Works, Inc.
35*	Forsyth	1.87	H S	59,867.61	2–25–20	County Commissioners
36*	Durham	3.46	H S	115,075.57	12–15–19	R. G. Lassiter & Company
37	Gaston	10.38	H S	167,173.23	12–28–21	County Commissioners
38*	Rockingham	10.92	G	46,809.92	9–17–20	County Commissioners
38A	Caswell	6.67	G	50,907.23	7– 6–21	Bolton Construction Co.
39	Union	10.61	G	74,337.71	4– 9–21	County Commissioners—J. S. Stearns
40*	Union	4.287	G	18,434.20	12–11–20	County Commissioners
41	Watauga	8.95	G	94,681.29	11–10–21	County Commissioners
42*	Stanly	11.67	G	80,922.15	9–10–20	Gibson Construction Company
43*	Beaufort	2.2	H S	95,089.12	5–11–20	Simmons Construction Company
44*	Granville	4.57	G	51,377.43	4–20–21	T. W. Chandler—P. R. Ashby
45	Buncombe	7.852	H S	359,777.28	7–23–21	H. A. Wells-Asheville Const. Co.—Asheville Paving Company
47*	Guilford	4.607	H S	162,689.83	4– 8–21	County Commissioners
48A*	Northampton	5.804	G	60,620.51	10–30–20	Virginia Contracting Company
48B	Northampton	2.69	G	44,749.65	10– 4–20	Porter & Peck–A. C. House
50*	Guilford	2.65	H S	101,596.44	12–31–20	County Commissioners

(Continued on next page)

STATUS OF FEDERAL AID WORK IN NORTH CAROLINA---*Continued*

Projects Completed (Continued)

NO.	COUNTY	LENGTH	TYPE	APPROXIMATE COST	COMPLETED	CONTRACTOR
51	Guilford	2.26	H S	$ 87,603.12	9–27–20	County Commissioners
52	Cabarrus	8.986	G	162,399.61	3–22–21	Gibson Construction Co.—J. E. Lane
54*	Wake	6.811	H S	239,736.26	8–23–20	R. G. Lassiter & Company
55A*	Mecklenburg	6.008	H S	196,899.73	12–28–20	Simmons Construction Company, Inc.
55B	Mecklenburg	4.59	H S	188,445.18	8–13–21	Simmons Construction Co., Inc.
56*	Forsyth	5.868	G	47,709.31	10–29–20	C. B. Hester-Luten Bridge Company
57	Rowan	6.75	G	72,549.27	4–22–21	W. E. Graham—R. M. Hudson Company
59	Columbus	11.025	G	106,872.26	1–26–22	County Commissioners
62	Buncombe	3.43	H S	139,191.32	11– –21	H. C. McCrary, Inc.—Asheville Construction Co.
63	Buncombe	3.76	H S	167,933.55	9–20–21	Allport & Alexander Construction Co.—H. C. McCrary, Inc.—Asheville Paving Company
65	Pitt	9.57	G	99,181.06	10–20–21	Porter & Peck
67*	Nash	8.81	H S	384,126.08	4–20–21	R. G. Lassiter—Atlantic Bridge Company
71	Durham	6.69	H S	319,153.39	10–26–21	State Forces
72*	Anson	3.896	G	70,470.89	3– 4–21	Gibson Construction Co.—J. A. Kreis & Co.
74A*	Stanly	2.803	G	25,537.45	8–20–20	County Commissioners
74B	Stanly	4.92	G	63,411.26	5– –21	County Commissioners
76*	Cabarrus	1.35	H S	54,583.76	10–29–20	R. M. Hudson & Company
77	Rutherford	2.206	H S	100,159.44	9– 5–21	E. T. Belote
78A	Rutherford	9.64	G	88,230.71	8– 3–21	Ross Brothers.
78B	Rutherford	10.26	G	71,056.48	8– 3–21	Ralph E. Oliver
79*	Cleveland	1.645	H S	67,063.64	10–30–20	Noll Construction Company
80A	Montgomery	16.6	G	226,516.20	6–20–21	County Commissioners
80B	Montgomery	11.07	G	65,145.02	10–25–21	Lee J. Smith Const. Co.—P. R. Ashby
81	Pender	26.11	G	273,439.45	12– –21	Porter & Boyd
82	Davidson	4.54	G	59,983.71	12–18–20	Heilig & Sherrill
84A	Burke-McDowell	8.33	G	128,193.76	8– 3–21	J. A. Kreis & Company
84B	McDowell	6.76	G	109,659.49	8– 1–21	J. A. Kreis & Company
85*	Davie	8.28	G	58,756.89	9–26–20	W. E. Graham
91*	Surry	10.68	G	113,805.84	6–27–21	W. E. Graham—R. W. Curtis & Co.
92*	Surry	10.83	G	133,141.03	6–20–21	W. E. Graham—R. W. Curtis & Co.
98C	Lee	4.53	G	18,240.64	10–29–21	Gibson Construction Co.
99A	Chatham	12.65	G	126,717.70	8–11–21	T. W. Chandler—State Forces (Bridges)
100	Avery	14.00	H S	272,089.78	11– –21	Southern Dray Company
101A	Randolph	10.04	G	123,893.99	8–12–21	S. L. Davis—J. A. Kreis & Co. (Bridges)
105	Hoke	9.8	G	95,501.80	10–25–21	Jameson Brothers—George, Hankins & George
107	Madison	2.46	G	70,910.40	10– –21	Southern Dray Company
109	Burke	3.58	G	55,191.64	5–21–21	C. E. Teague
111	Forsyth	12.22	G	94,447.10	8–17–21	C. B. Hester—Heilig & Sherrill
112	Caswell	11.93	G	147,065.71	11– 2–21	J. M. Gregory—J. E. Lane & Co. (Bridges).
114*	Rowan	2.543	H S	83,587.02	3–17–21	R. M. Hudson & Company
116	Stanley-Montgom'	....	Bridge	199,614.80	1– 9–22	Cornell-Young Company
121	Stokes	11.60	G	108,519.62	1–14–22	Jameson Bros.—Rogers & Shumway (Bridges)
129	Richmond	17.28	G	77,507.48	12– –21	Mulligan & Roach

*Final Settlement Made With Federal Government

STATUS OF STATE WORK IN NORTH CAROLINA

Projects Under Construction

"H S" denotes any type hard surfaced road.

"G" denotes any type of gravel, sand clay, or topsoil road.

NO.	COUNTY	LENGTH	TYPE	APPROXIMATE COST	BEGUN	CONTRACTOR
100	Beaufort	10.50	H S	$ 369,777.70	8–23–21	W. T. Hadlow.
113	Chowan	10.32	G	40,975.73	2—1—22	Nello L. Teer—P. R. Ashby.
114	Chowan	10.00	G	45,064.09	1—4—22	Battershill & Goode—Chandler P Ragland.
125	Edgecombe	15.11	H S	428,438.76	2—28—22	R. G. Lassiter & Co.
137	Halifax	5.67	H S	124,736.97	10–31–21	O. F. Leighton—A. C. House.
139	Halifax	....	Bridge	18,436.66	10–11–21	Chandler & Ragland—Porter & Peck.
151	Hyde	4.30	G	71,422.78	12–10–21	C. W. Lacy—Porter & Peck.
155	Martin-Pitt	20.00	G	98,176.65	1–12–22	J. P. Dicus—P. R. Ashby.
159	Nash	11.22	G	89,942.43	1—2—22	J. A. Kreis & Co.
160	Franklin-Wake-Nash	9.83	G	53,722.95	1–27–21	Chandler & Ragland—Southern Dray Co.
175	Pasquotank	9.50	H S	217,405.72	4—6—21	County Commissioners.
186	Pitt	9.75	H S	260,816.60	9–20–21	Cheatwood & Driscoll.
191	Tyrell	6.91	G	57,934.41	1–20–22	C. W. Lacy—M. M. Jones.
195	Washington	15.18	G	65,619.35	2–27–22	L. M. Lee & Co.—B. J. Boyles.
209	Craven	2.65	H S	115,688.21	8–00–21	Eagle Engineering Co.
218	Wayne-Duplin	16.06	G	80,804.50	8—4—21	C. W. Lacy.
227	Greene	6.81	H S	283,113.70	12–19–21	West Const. Co.—Union Paving Co.
280	Wayne	10.01	H S	311,352.36	11–28–21	Union Paving Company.
281	Wayne	....	Bridge	22,484.88	....	P. R. Ashby.
301	Bladen	13.17	G	82,028.21	11–12–21	J. F. Mulligan—Powell Paving & Cont. Co.
314	Brunswick	15.82	G	99,326.45	2–23–22	Hagedorn Const. Co.
325	Columbus	11.22	G	105,258.23	11—3—21	J. A. Kreis–Cornell–Young Co.
338	Cumberland-Sampson	....	Bridge	26,233.99	10–28–21	Roanoke Bridge & Iron Works.
339	Harnett-Cumb'l'nd	....	Bridge	16,524.75	11–30–21	Porter & Boyd.
375	Pender	15.56	G	72,522.92	11—1—21	A. W. McClay.
376	Pender	7.64	G	94,757.85	11–11–21	C. G. Kershaw Const. Co.—Cornell Young Co.

(Continued on next page)

STATUS OF STATE WORK IN NORTH CAROLINA---*Continued*

Projects Under Construction (Continued)

NO.	COUNTY	LENGTH	TYPE	APPROXIMATE COST	BEGUN	CONTRACTOR
388	Robeson	3.35	H S	$ 137,009.40	11-10-21	C. W. Lacy—Roanoke Bridge & Iron Works.
389	Roberson-Colum	1.56	G	83,463.38	10-26-21	L. A. Chitwood.
411	Durham	5.81	H S	211,574.92	9—1-21	Hutton Eng. & Const. Co.
427	Granville	5.12	H S	159,097.62	12- 1-21	R. G. Lassiter & Co.
436	Harnett	21.19	G	144,318.14	6-28-21	C. G. Kershaw Const. Co.—Hobbs & Kitchen.
454	Orange	4.29	H S	192,006.15	6-18-21	Elliott, Sholes & Teer
455	Orange	4.19	G	46,415.77	11-28-21	J. F. Mulligan Const. Co.—P. R. Ashby.
456	Orange	9.00	G	37,459.07	1- 7-22	Crawford & Crawford—Nello Teer.
482	Wake	6.64	H S	191,669.21	12- 8-21	R. M. Hudson Company.
501	Alamance	13.10	G	32,627.10	12- 7-21	W. M. Shook—Hanford Bros.
511	Caswell	14.8	G	74,192.58	12-12-21	White & Simpson—C. B. Hester.
525	Davidson	10.24	H S	363,141.68	12-23-21	Elliott & Sons & Boggs—Austin Bros. BridgeCo.
532	Guilford	11.70	H S	387,499.20	2—1-22	Elliott-Sholes Company.
533	Guilford-Forsyth	10.59	H S	427,997.62	7-11-21	Royer-Ferguson Const. Co.
630	Gaston	3.02	H S	98,392.36	10-12-21	W. F. McCanless.
632	Gaston	9.5	H S	291,868.94	1—2-22	Davis-Wilcox Const. Co.
638	Iredell	7.88	H S	244,509.30	10-12-21	Thompson-Caldwell Co.
639	Iredell	10.59	H S	387,448.42	1—2-22	R. M. Hudson Co.—Luten Bridge Co.
655	Mecklenburg	1.57	H S	62,027.68	12-21-21	Speed-Parker Co., Inc.—Luten Bridge Co.
657	Mecklenburg	13.8	G*	20,000.00	12- 8-21	State Forces.
700	Alleghany	7.90	G	132,297.33	6-23-21	W. E. Graham
701	Alleghany-Wilkes	8.00	G	153,863.60	6-16-21	W. E. Graham
710	Ashe	3.14	H S	142,687.93	9- 8-21	Pittman Const. Co.
725	Caldwell	2.4	G*	10,000.00	12-29-21	County Commissioners.
750	Stokes	14.86	G	93,054.48	9-15-21	J. F. Mulligan Const. Co.—Lee J. Smith
751	Stokes	7.25	G	31,746.00	10- 4-21	W. E. Graham
760	Surry-Wilkes	6.91	G	24,387.66	2-10-22	W. E. Graham.
780	Wilkes	18.00	G*	25,000.00	7-25-21	J. F. Mulligan.
781	Wilkes	14.50	G*	30,000.00	7-25-21	J. F. Mulligan.
783	Wilkes-Watauga	34.40	G*	80,000.00	9- 2-21	Chandler & Ragland.
811	Burke	6.0	H S	189,412.41	1-13-22	Southern Dray Company.
823	Cleveland	2.0	H S	81,234.01	1—2-22	Southern Paving Co.—Z. B. Weathers & Son.
833	Henderson	10.22	G	38,412.44	1—3-22	S. L. Davis Const. Co.—Asheville Const. Co.
845	McDowell	7.19	G	132,177.93	9- 6-21	J. W. Stapp Const. Co.—Praytor, Howton, Wood Const. Co.
846	McDowell	10.06	G	204,680.74	9-12-21	Asheville Const. Co.—W. T. Taylor Const. Co.
855	Mitchell	4.97	H S	174,393.78	9-12-21	Fiske-Carter Construction Co.
877	Rutherford	9.79	G	64,563.73	5-31-21	Geer & Wilson
878	Rutherford	6.55	G	50,913.50	9-22-21	Michaux Const. Co.—Geer & Wilson.
879	Rutherford		Bridge	5,737.38	1—9-22	Austin Bros. Bridge Co.
910	Cherokee	7.56	G	76,743.59	5-24-21	Ross Bros.—W. T. Moore Conc. Prod. Co.
911	Cherokee	10.33	G	84,475.38	10-25-21	H. A. Wells—Southern Dray Co.
920	Clay	4.8	G	54,875.81	1—9-22	E. A. Wilson & Co.—W. T. Moore Conc. Prod. Co.
921	Clay	12.37	G	123,929.52	10-24-21	Lee J. Smith Const. Co.—W. T. Moore Conc. Prod. Co.
930	Graham	12.90	G	130,522.00	10-15-21	Lee J. Smith Const. Co., C. M. Dicus.
942	Haywood	0.57	G	5,294.46	7-12-21	O'Brien Construction Co.
950	Jackson	7.56	G	145,313.30	6-13-21	Wright & Nave—O'Brien Const. Co.
960	Macon	4.97	G	69,100.57	6- 6-21	J. T. Plott—J. E. Lane & Co.
961	Macon	4.77	G	58,340.59	12- 5-21	J. T. Plott—J. E. Lane & Co.
970	Madison-Yancey	13.80	G	267,378.26	10-11-21	R. H. Wright & Sons—O'Brien Const. Co.

Projects Completed

NO.	COUNTY	LENGTH	TYPE	APPROXIMATE COST	BEGUN	CONTRACTOR
500	Alamance	5.22	G	32,732.20	1-17-22	W. W. Tuck & Son—A. M. Hazell, Connerate—Quist Const. Co.
692	Union	2.28	H S	65,366.67	12-28-21	Redmon Construction Co.
722	Caldwell	7.00	G*	12.000.00	1-18-22	County Forces.
844	McDowell	1.80	H S	57,048.42	12-28-21	Bolton Construction Co.

*Reconstruction only.

Projects Under Contract

NO.	COUNTY	LENGTH	TYPE	APPROXIMATE COST	CONTRACTOR
140	Halifax		Bridge	$ 10,542.69	Von Glahn & Talbott.
154	Martin	11.27	H S	394,090.74	Sou. Willite Paving Co.—O. F. Leighton, Inc.
166	Northampton	0.47	G	17,954.75	W. D. Murray—Sadler Corp.
183-B	Pitt		Bridge	32,343.30	B. J. Boyles.
185	Pitt	14.35	G	31,069.72	J. A. Marrow.
196	Washington	14.93	G	82,099.60	W. N. Thompson—Nello L. Teer.
210	Craven	8.34	H S	287,919.39	Union Paving Co.—A. P. Gilbert.
211	Craven	9.93	H S	262,673.20	Union Paving Co.
245	Jones	15.76	H S	244,737.90	Hyde & Baxter.
263	Pamlico	12.03	H S	289,324.20	Union Paving Company.
272	Sampson	16.47	G	98,807.39	R. E. Martin–Striblin–Stauddy & Newell.
291	Wilson	7.63	H S	203,493.18	P. R. Ashby.
300	Bladen	11.99	G	65,178.90	T. W. Chandler—Nello Teer.
313	Brunswick	3.44	H S	105,389.85	Sou. Willite Paving Co.—Roanoke Bridge & Iron Works
364-A	Onslow	9.95	G	44,631.40	R. E. Martin.

(Continued on next page)

STATUS OF STATE WORK IN NORTH CAROLINA---*Continued*

PROJECTS UNDER CONTRACT (*Continued*)

NO.	COUNTY	LENGTH	TYPE	APPROXIMATE COST	CONTRACTOR
377	Pender-Duplin	1.61	G	$ 76,985.70	R. E. Martin–Hazell–Connerat–Quist Co.
400	Chatham	....	Bridge	57,420.22	R. M. Walker & Co.
409	Durham	0.5	H S	6,140.64	J. P. Dicus.
410	Durham	2.3	H S	83,921.97	C. D. Riggsbee.
453	Orange	....	Bridge	33,706.80	Geo. W. Kane.
481	Wake	7.20	H S	252925.15	Union Paving Co.—P. R. Ashby.
483	Wake	0.54	H S	19,989.75	C. D. Riggsbee.
504	Alamance	5.22	H S	154,127.16	Elliott–Sholes Company.
505	Alamance	0.42	H S	15,316.40	Hedrick Construction Co.
526	Davidson	3.77	H S	130,826.19	Hagedorn Const. Co.—Heilig & Sherrill.
538	Guilford	....	Bridge	7,555.90	J. L. Brinkley.
566	Moore	7.14	G	61,380.66	Gibson Const. Co.—Nello Teer.
567	Moore	2.96	G	7,690.43	C. E. Teague.
577	Randolph	13.37	H S	411,375.77	Royer–Ferguson Co., Inc.—J. L. Brinkley.
606	Stanley-Anson	....	Bridge	54,759.32	Concrete Steel Bridge Co.
607	Anson	6.39	G	40,517.29	Geer & Wilson—Booz–Lloyd & Co.
622	Catawba	10.85	H S	354,684.88	Union Paving Company.
653	Mecklenburg	8.84	H S	308,182.44	Union Paving Co.—Luten Bridge Co.
654	Mecklenburg	10.1	H S	302,887.09	Lampton & Burks.
695	Union	4.3	H S	123,865.28	Redmon Const. Co.
731	Davie	5.46	H S	195,393.11	G. R. Martin-Heilig & Sherrill.
782	Wilkes	5.97	H S	184,614.65	Hyde & Baxter.
855-B	Mitchell	....	Bridges	7,454.15	Luten Bridge Co.
856	Mitchell	4.0	H S	239,005.80	Porter & Boyd—L. J. Chandler & Co.
860	Mitchell	5.58	H S	152,908.42	J. F. Mulligan—W. H. Anderson Const. Co.
880	Rutherford	....	Bridge	24,679.43	Austin Bros. Bridge Co.
904	Buncombe	1.60	H S	81,079.35	Asheville Paving Co.—R. C. Stevens.
940	Haywood	7.13	H S	126,082.00	Alexander & Patton–H. A. Brown & Co.
980	Macon–Swain	17.9	G	344,161.29	E. A. Wilson & Co.—Southern Dray Co.

Summary

	NUMBER OF PROJECTS			MILEAGE		APPROXIMATE TOTAL COST		
	H S	G	BRIDGE	H S	G	H S	G	BRIDGE
UNDER CONSTRUCTION								
Federal Aid Projects	5	26	1	30.38	285.12	$ 901,972.52	$3,290,573.63	$ 332,308.83
State Projects	25	45	5	176.41	482.53	5,853,300.65	3,583,103.48	89,417.66
Total Under Construction	30	91	6	206.79	767.65	6,755,273.17	6,873,677.11	421,726.49
UNDER CONTRACT Construction not yet begun								
Federal Aid Projects	....	....	....	....	....	....	....	....
State Projects	25	4	8	165.57	104.16	4,930,950.51	870,477.13	228,461.81
Total Under Contract	25	4	8	165.57	104.16	4,930,950.51	870,477.13	228,461.81
COMPLETED								
Federal Aid Projects	26	55	3	122.05	477.68	4,039,583.81	4,107,985.75	309,637.70
State Projects	2	2	....	4.08	12.22	122,415.09	44,732.20	....
Total Completed	28	57	3	126.13	489.90	4,161,998.90	4,152,717.95	309,637.70

Total mileage of Hard Surface work under construction or contracted for	372.36
Total mileage of Topsoil, Sand Clay or Gravel work under construction or contracted for	871.81
Total mileage under construction or contracted for	1,244.17
Total cost of Hard Surface work under construction or contracted for	$ 11,686,227.68
Total cost of Topsoil, Sand Clay or Gravel work under construction or contracted for	7,744,154.24
Total cost of Bridge work under construction or contracted for	650,188.30
Grand Total cost of work under construction or contracted for	$ 20,080,570.22
Total mileage of Hard Surface work completed	126.13
Total mileage of Topsoil, Sand Clay or Gravel work completed	489.90
Total mileage of work completed	616.03
Total cost of Hard Surface work completed	$ 4,161,998.90
Total cost of Topsoil, Sand Clay, or Gravel work completed	4,152,717.95
Total cost of Bridge work completed	309,637.70
Grand Total of all work completed	$ 8,624,354.55

Corrected to March 1, 1922

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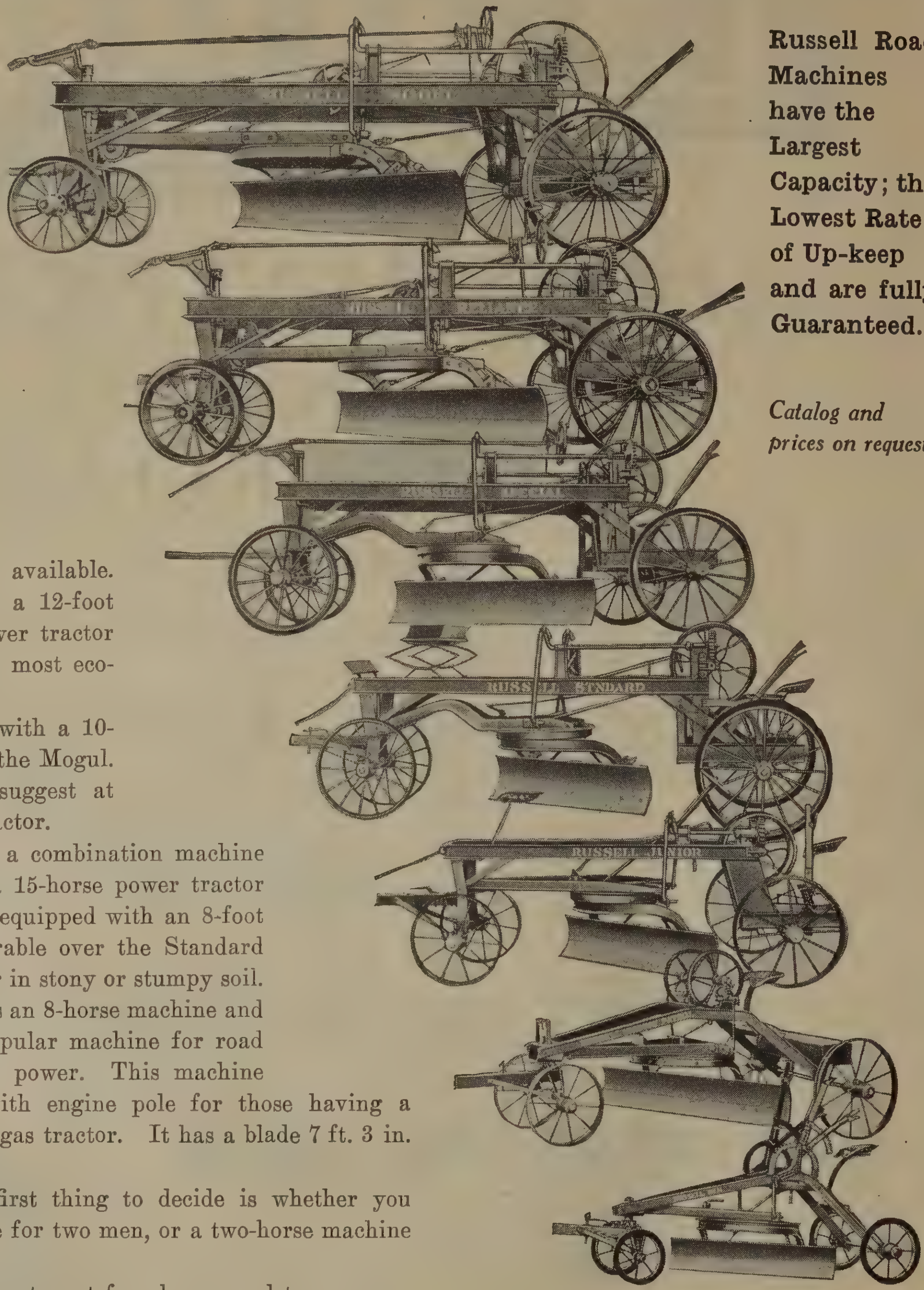

A RUSSELL ROAD MACHINE FOR EVERY NEED

Before deciding upon a road machine let us assist you by suggesting what we consider best for your requirements. We make this offer because we know that this is one of your problems. The first thing to decide upon is whether you want a machine for construction or maintenance; for horse power or tractor power.

For Construction buy the largest machine for which power is available. The *Russell Mogul* with a 12-foot blade and a 25-horse power tractor will construct your roads most economically.

The *Russell Reliance,* with a 10-foot blade, ranks next to the Mogul. With this machine we suggest at least a 20-horse power tractor.

The *Russell Special* is a combination machine for which you may use a 15-horse power tractor or 8 or 12 horses. It is equipped with an 8-foot blade and is often preferable over the Standard for use with animal power in stony or stumpy soil.

The *Russell Standard* is an 8-horse machine and is, no doubt, the most popular machine for road construction with animal power. This machine may also be equipped with engine pole for those having a small 8 to 15-horse power gas tractor. It has a blade 7 ft. 3 in. long.

For Maintenance the first thing to decide is whether you want a four-horse machine for two men, or a two-horse machine for one man.

For those who are willing to put four horses and two men on the grader, the *Russell Junior* will do maintaining work more effectively than any other grader. This machine has a 6-foot blade and may be used for light road construction as well as maintenance.

The *Russell Hi-Way Patrol* grader is built especially for greatest efficiency in patrol and maintenance work with two horses and one man. It is lighter than the Junior and is equipped with a 6-foot blade. Blade is operated by worm and gear lift, giving the finest kind of adjustment.

The *Russell Gem* is the cheapest of the high-framed type machines. It is equipped with 5-foot, one-piece, reversible blade. The blade is operated by lever. It is a one-man, two-horse machine.

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If you want anything in the way of used machines that must be about as good as new write us.

At this time we have going through our shops, rebuilding, the following:

Ten ton steam roller, Five ton tandem roller, One bag light mixer, 3½ ton Kelly Truck, Monarch Tractor, Three hoisting engines, Two air compressors, Pipe threading machine, 44 ins. engine lathe, 5 ton Alco Truck, 5 drill presses, No. 3. Keystone shovel, one paving mixer, etc., etc., etc.

We have a full line of slightly used plants on which we can save you money.

Let us have your inquiries.

We have a number of good pieces of plant that we will rent to responsible people.

This will save you buying equipment for the small contracts.

We have to rent now: No. 3 Keytone Hoisting engine D. C. 7 x 10, D. D. with boiler. Ten ton steam roller, Five ton tandem roller, 30 h. p. crawler type tractor, Thew Steam shovel, Two small air compressors with gasoline engines, Air compressor with electric motor, 21-S Mixer with boiler, engine, sideloader and tank, One-bag gasoline mixer loader and tank, 1250 yard Asphalt plant-complete.

All above plant is our own property and fully guaranteed.

Write us for terms.

We can use a few good sub-agents in the larger towns in all three states. If you visit contractors and can sell machinery we can put you in position to make some good extra money.

Sixteen years in business — our customers our references

LEWTER F. HOBBS, INC.

NORFOLK, VA.

Offices and show rooms
113-115 East Twelfth St.

Private Telephone Exchange
23908

Machine shops
835-837 West 38th. St.

Permanent Construction Concrete **Minimum Maintenance**

Solves the Road Problem

The concrete road is gaining in favor in all parts of the United States. Whether laid in North or South, East or West, in all varieties of climate and under widely varying conditions, the concrete road is meeting with success and is solving the problem of securing a roadway at reasonable cost that will stand up under modern traffic conditions.

Public approval and appreciation of the concrete road is based upon practical observation as to its extreme utility, reasonable first cost and the almost negligible outlay required for maintenance.

The most important question in road building today is that of maintenance.

The one aim and desire of road officials and engineers has been to find a material, the use of which would keep maintenance charges at a minimum.

In Bellefontaine, Ohio, the maintenance cost of a concrete road put down 20 years ago has averaged only one-fourth of a cent per square yard per year.

In Wayne County, Michigan, the maintenance on 60 miles of concrete road laid 1909 to 1912 was less than one-sixth of a cent per square yard for three years.

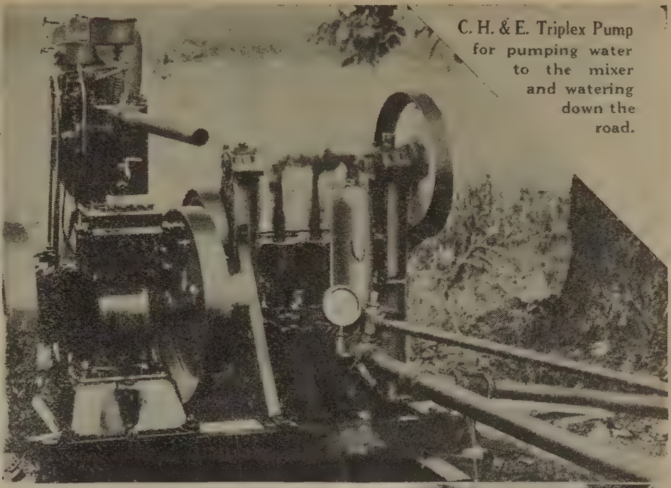
Concrete, therefore, completely answers the maintenance question.

And this combined with reasonable first cost makes it the ideal material for a modern road to meet modern conditions.

CLINCHFIELD PORTLAND CEMENT CORP.

Office and Mills: KINGSPORT, TENN.

HELTZEL STEEL ROAD FORMS "BUILT LIKE A RAIL ROAD"



C. H. & E. Triplex Pump for pumping water to the mixer and watering down the road.

GENERAL UTILITIES COMPANY

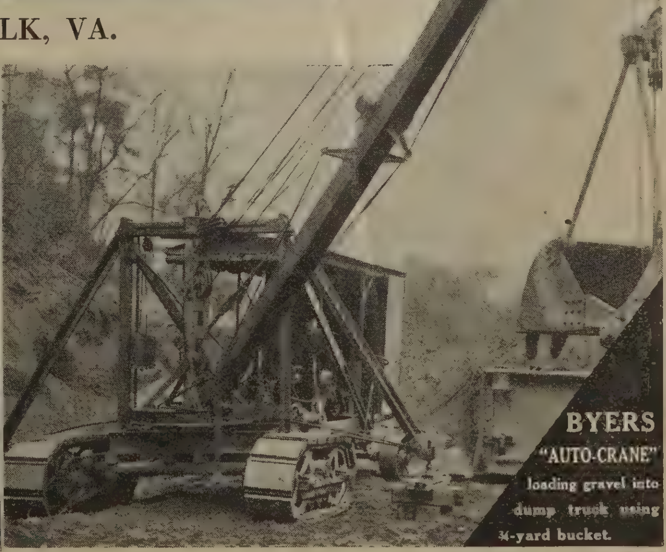
This Barber-Greene Loader replaced 13 laborers. See one with crawler traction on the Norfolk-Virginia Beach Road.

NORFOLK, VA.

Steam Shovels
Mixers
Pumps
Stone Loaders
Hoists

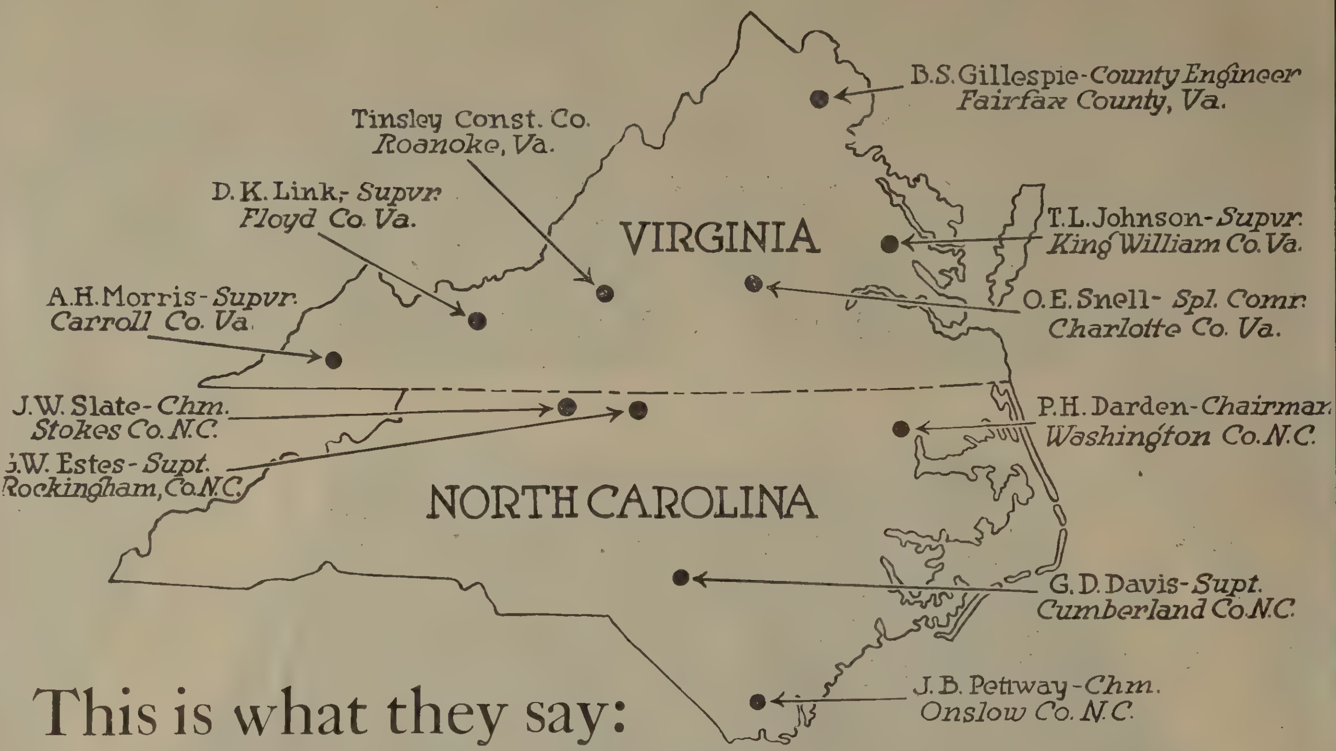
Conveyors
Derricks
Gasoline Locomotives
Steel Forms
Cranes

Plymouth Gasoline Locomotive Speeding up delivery to the Paver.



BYERS "AUTO-CRANE" loading gravel into dump truck using ¾-yard bucket.

Here's Where they are Located:


B.S. Gillespie-*County Engineer* *Fairfax County, Va.*
Tinsley Const. Co. *Roanoke, Va.*
D.K. Link-*Supvr.* *Floyd Co. Va.*
VIRGINIA
T.L. Johnson-*Supvr.* *King William Co. Va.*
A.H. Morris-*Supvr.* *Carroll Co. Va.*
O.E. Snell- *Spl. Comr.* *Charlotte Co. Va.*
J.W. Slate-*Chm.* *Stokes Co. N.C.*
P.H. Darden-*Chairman* *Washington Co. N.C.*
J.W. Estes-*Supt.* *Rockingham, Co. N.C.*
NORTH CAROLINA
G.D. Davis-*Supt.* *Cumberland Co. N.C.*
J.B. Pettway-*Chm.* *Onslow Co. N.C.*

This is what they say:

"We believe the HOLT "CATERPILLAR" Tractor to be the best possible method for building and maintaining Roads."

We believe the HOLT "CATERPILLAR" Tractor to be the cheapest possible method for building and maintaining Roads."

We believe the HOLT "CATERPILLAR" Tractor will give the best possible satisfaction in building and maintaining Roads."

There's lots of "history" connected with this:

Fairfax County bought their first "five" sometime ago and have added a "ten."

After the first purchase additional "CATERPILLARS" have been added by Charlotte and Floyd Counties, Virginia, and Washington, Cumberland and Rockingham Counties, North Carolina.

This tells the whole story!

THERE'S BUT ONE "CATERPILLAR" HOLT BUILDS IT

Have you placed an order for yours? If not communicate with

TRACTOR & MACHINERY SALES COMPANY
1631 WEST BROAD STREET, RICHMOND, VA.

DISTRIBUTORS

THE AUSTIN.WESTERN ROAD MACHINERY CO.
THE HOLT MANUFACTURING COMPANY
BAKER-MANEY WHEELER

Fort Fisher Highway, New Hanover Co., N. C. Treated with "Tarvia-B" 1915-17-18-19 and "Tarvia-A" in 1916.

Above is Wrightsville Turnpike, New Hanover Co., N. C. Treated with "Tarvia-A" 1915, and with "Tarvia-B" 1917.

Another view of Fort Fisher Highway.

"The Best Investment The Board Ever Made"

Mr. Addison Hewlett, Chairman of the Board of Commissioners of New Hanover County, N. C., writes, under date of July 25, 1921:

"We have been using Tarvia for surface treating the macadam roads of New Hanover County for the past six years, and we find this treatment satisfactory in every respect.

"Before we started the use of Tarvia we had great difficulty in maintaining our roads, as they became very dusty in dry weather and washed away in wet weather, leaving our road surface full of holes and ruts. Since using Tarvia the surface of the roads has been well protected in all kinds of weather, and today our roads have smooth, hard surfaces and our maintenance problem has been very easily solved. The Tarvia treatment is very inexpensive.

"It is unquestionably the best investment the Board of Commissioners has ever made and the Commissioners would not consider for a moment discontinuing Tarvia on our roads."

Tarvia
For Road Construction Repair and Maintenance

Additional comments on Tarvia are made by R.. A. Burnett, County Superintendent of Roads:

"Tarvia treatments are given to some of our roads every year while other roads, such as the Wrightsville Turnpike, have lasted as long as three years before requiring another treatment.

"These treatments have cost us in the neighborhood of $300 per mile per year and have proved to be the best, easiest and cheapest method of maintaining our roads. We have always had the best of co-operation from your engineers . . .

"We feel that we have a finer system of roads than any other county in the State."

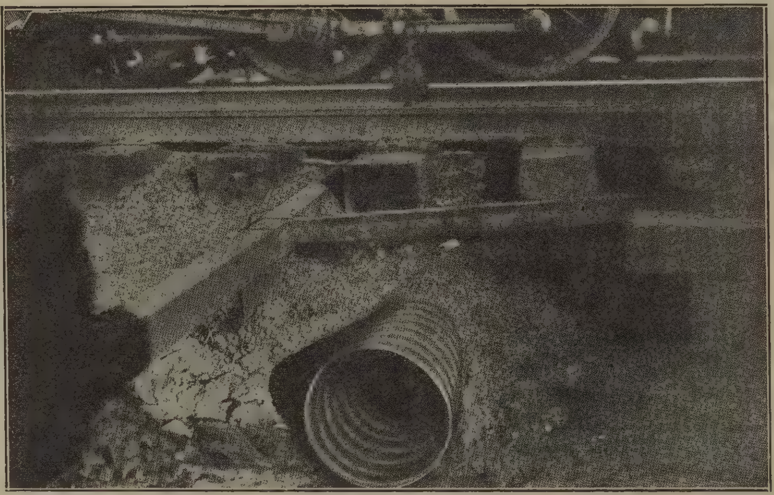
No matter what your road problems may be—new construction, maintenance, or repairs—there is a grade of Tarvia made especially for the purpose.

Write for free illustrated booklet describing the various uses of Tarvia

36th and Grey's Ferry Avenue The Barrett Company **Branches in All Leading Cities** TRADE B MARK **PHILADELPHIA, PA.**

PURE IRON LASTS LIKE THIS

Pure iron nails from coffin of soldier buried at Fort St. Clair, Ohio, U.S.A. After being 100 years in the ground, they are practically undamaged by rust. Analysis shows them to be 99.83% pure iron, containing only the merest traces of carbon, copper and sulphur.



The Engineer of the Atlanta Terminal Company says that the Armco Culvert pictured here is in such good condition today that it ought to last several times the ten year period during which it has already withstood the acid waters which go thru it in the Railroad yards, as well as the pounding of the 450,000 heavy trains which have gone over it.

AMERICAN
ARMCO
INGOT IRON

THE DIXIE CULVERT AND METAL COMPANY

Little Rock, Ark. **ATLANTA, GA.** Jacksonville, Fla.

J. GRANVILLE BALDWIN,
Charlotte, N. C.

W. H. McNEILL,
Lakeview, N. C.

NORTH STATE CULVERT
and MACHINERY COMPANY

217 Lewis Street

TELEPHONE 2933

Postoffice Box 166

Greensboro, North Carolina

GENERAL LINE OF ROAD BUILDING MACHINERY, CONTRACTORS' EQUIPMENT AND CULVERTS. A NEW NORTH STATE FIRM BUT OLD IN EXPERIENCE IN SUPPLYING WHAT YOU WANT.

LET US KNOW YOUR WANTS

ROAD **MULTI FOOTE** PAVER
TRADE MARK REGISTERED

EVERY FOOTE A MIXER

Fourth Year of the MultiFoote Paver

Foote perfected and brought out the first road paver with full-length caterpillar type traction in 1919.

Like most notable paving mixer improvements that have been pioneered by Foote, the MultiFoote was an idea developed on the job—in watching and studying the operation of many Foote Pavers built before it.

The **MultiFoote** traction lays its own planking. It saves all delays in moving. It steeers by power, turns in its own length. It has less ground pressure than the average walking man and travels easily over the softest sub-grade. Paving contractors were quick to appreciate these important advantages—the **MultiFoote** was an assured success from the start. In less than two years the **MultiFoote** traction almost entirely replaced the old wheel type traction.

For these reasons the Foote plant—undoubtedly the largest factory manufacturing paving mixers exclusively—has for more than two years and will during 1922 be devoted entirely to the production of the two sizes of MuliFoote Pavers.

General Southern Agent

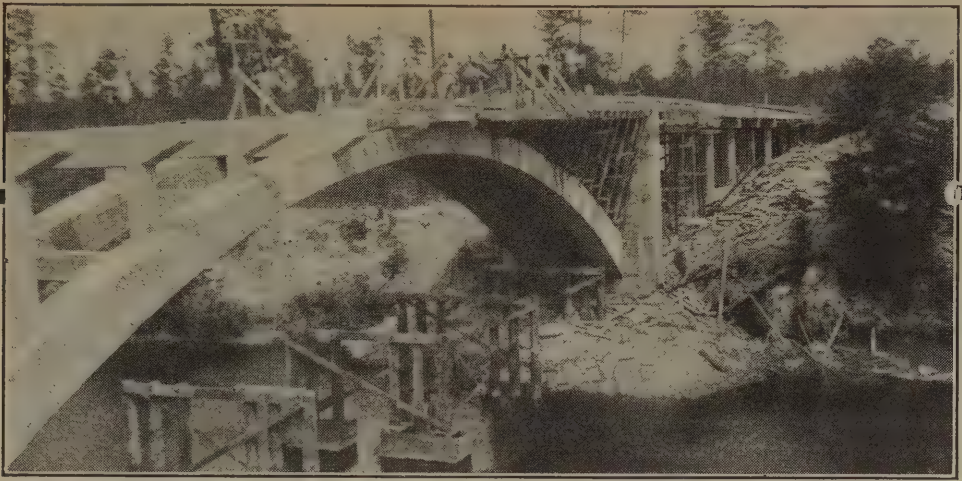
Burton Franklin, Chattanooga, Tenn.

NORTH CAROLINA AGENT

E. F. CRAVEN, *"THE ROAD MACHINERY MAN"*

GREENSBORO

Made by THE FOOTE CO. INC., NUNDA, N. Y.



Ga. Fed. Aid Proj. No. 136, a Slag concrete bridge over Withlacoochee river between Brooks and Lowndes counties, Ga. Built by Nichols Contracting Co., of Atlanta.

SLAG CONCRETE *is the*

Standard Type *of* Bridge Construction *in* Georgia

"ENSLEY" & "ALA CITY"

BASIC SLAG

CRUSHED & SCREENED

These two bridges are typical of the splendid structures now being built in Georgia under State and Federal Aid direction. Top photo shows a 738 ft. Slag concrete bridge over the Withlacoochee river between Brooks and Lowndes counties. It was opened to traffic in the summer of 1921.

The bridge shown in lower photo—also Slag concrete—is F. A. P. No. 11, and consists really of two bridges; one of 372 ft. over the Withlacoochee river and one of 324 ft. over the slough in Lowndes county. They are at the north end of F. A. P. No. 91, 4.92 miles of slag concrete road on National Highway just north of Valdosta. This road and these splendid bridges were completed by Nichols Contracting Co., several months ago.

Georgia is a firm believer in the economy of Concrete bridges. She knows from experience that they require no painting, have no wood floors to replace and that they grow stronger as they grow older.

Georgia also believes firmly in the use of our Basic Slag as the "coarse aggregate" in her concrete bridges. For experiments have indicated—and experience has proved—that SLAG stands highest both in compression and tensile strength.

Birmingham Slag Co.

"Slag Headquarters for the South"

Atlanta BIRMINGHAM Thomasville

Ga. Fed. Aid Proj. No. 11. A slag concrete bridge 696 ft. long that spans the Withlacoochee river north of Valdosta, Ga.

SIR FABRIC

OUT of the smoke and steam of the furnaces—the sweat, labor and toil of the swarthy, sinewy, half naked workers of the steel industry—Pittsburgh is typified, in mural paintings, as an armored knight, rising triumphant—crowned by the guardians of success.

Just as the strength and power of Pittsburgh has been depicted as a mail clad warrior—

So, SIR FABRIC, rising from the plant of the National Steel Fabric Company (the largest in the world devoted to the manufacture of welded steel fabric) is today the Armored Defender of Reinforced Concrete, and stands incarnate for your protection.

Over the country's highways you ride upon his broad shoulders; in your home he stands four square to the winds that blow; and the factory and office workers of the land are safe upon his rigid floors.

SIR FABRIC characterizes National Steel Fabric in its strength, stability, long life and crowned success.

Write for Catalogues

National Steel Fabric Company
(Subsidiary of Pittsburgh Steel Co.)
714 Union Arcade · Pittsburgh, Pa.

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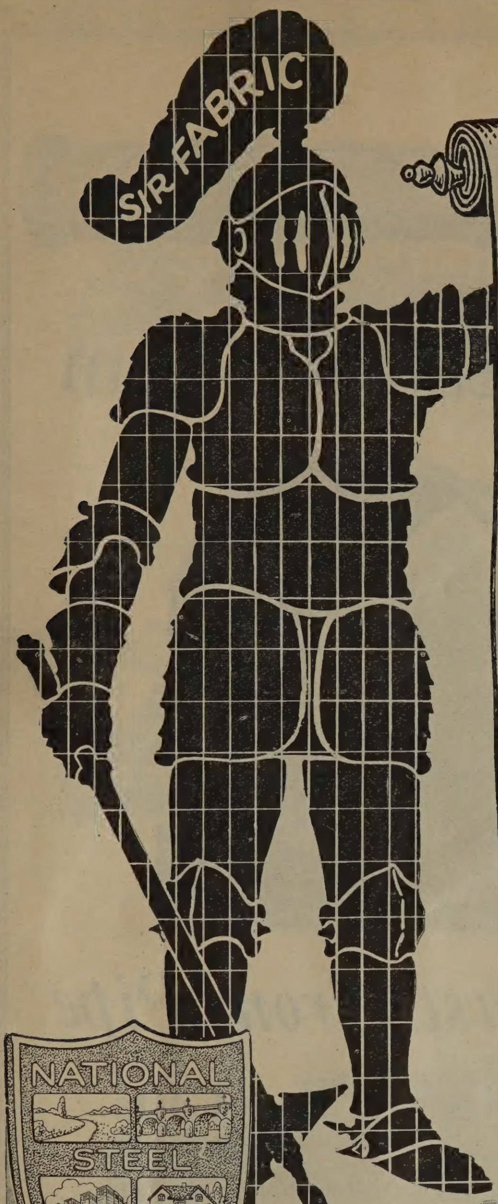
KANSAS CITY LOS ANGELES MINNEAPOLIS PHILADELPHIA
PORTLAND ST. LOUIS SAN ANTONIO SAN FRANCISCO
SEATTLE SPOKANE

"Cooperation Stimulates Service"

NATIONAL STEEL FABRIC CO
Subsidiary of PITTSBURGH STEEL CO
UNION ARCADE BUILDING PITTSBURGH, U.S.A



Be It Known

That the Commonwealths of Pennsylvania, North Carolina, New Jersey, Ohio, and New York have adopted the following new specifications covering fabric reinforcement for concrete highways:

STATE	MAIN WIRES			SECONDARY WIRES			Approximate Weight per 100 Sq. Ft.	National Steel Fabric Co. Style No.
	Gauge	Spacing	Cross-Sectional Area per Foot of Fabric	Gauge	Spacing	Cross-Sectional Area per Foot of Fabric		
Pennsylvania	0	6″	.148 Sq. In.	6	12″	.029 Sq. In.	65.7 Lbs.	CF06
New York . .	0	6″	.148 Sq. In.	6	12″	.029 Sq. In.	65.7 Lbs.	CF06
New Jersey . . .	0	6″	.148 Sq. In.	6	12″	.029 Sq. In.	65.7 Lbs.	CF06
Ohio	3	4″	.140 Sq. In.	7	12″	.025 Sq. In.	59.3 Lbs.	BF37
N. Carolina .	1½	4″	.176 Sq. In.	5	12″	.034 Sq. In.	75.4 Lbs.	BF1½5

Sir Fabric

Write for the new National Steel Fabric Catalog---it contains extracts from the specifications referred to, as well as much other data of vital interest to road engineers and contractors.

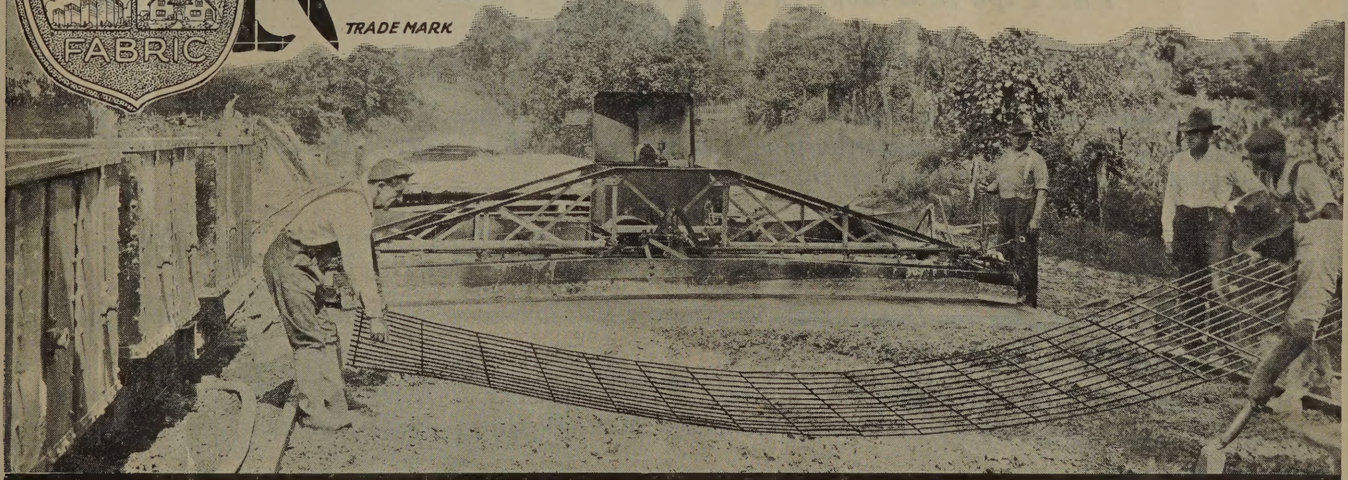
National Steel Fabric Company

(Subsidiary of Pittsburgh Steel Co.)

714 Union Arcade - Pittsburgh, Pa.

ATLANTA BUTTE CHICAGO CLEVELAND DENVER DETROIT KANSAS CITY
LOS ANGELES MINNEAPOLIS PHILADELPHIA PORTLAND ST. LOUIS
SAN ANTONIO SAN FRANCISCO SEATTLE SPOKANE

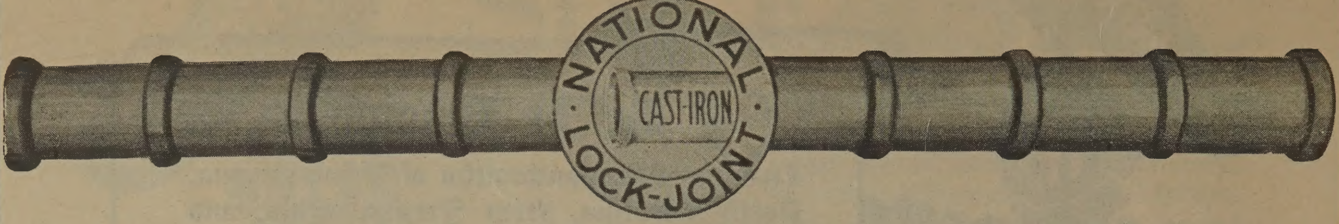
"Cooperation Stimulates Service"



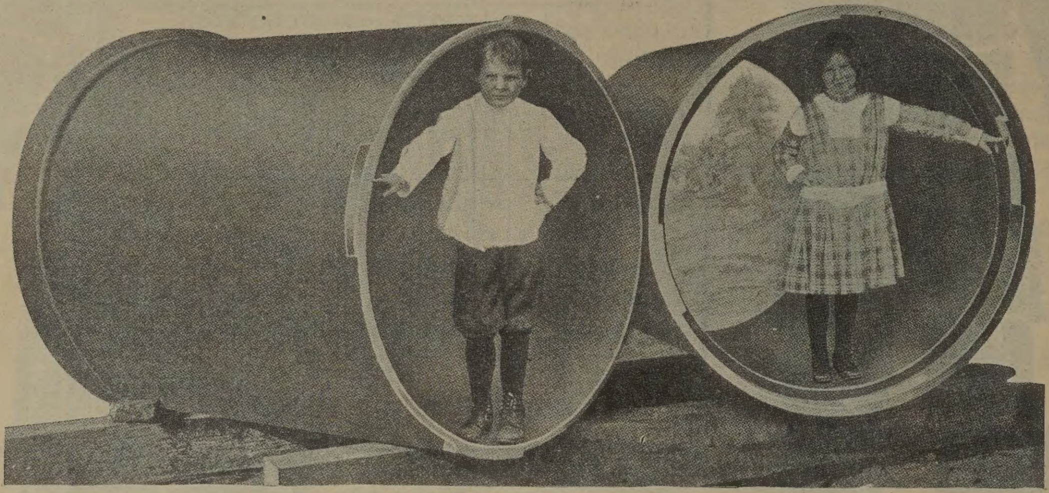
NATIONAL STEEL FABRIC CO

Subsidiary of PITTSBURGH STEEL CO

UNION ARCADE BUILDING PITTSBURGH, U.S.A



Long Years *of* Life Ahead *of* Them



National Lock-Joint Cast-Iron Pipe

The Pipe *of* Short Units, Long Service *and* Low Costs

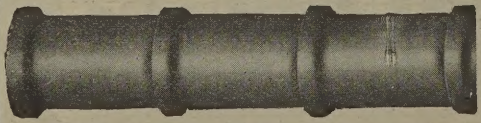
The Pipe that locks effectively, that prevents Separation and assures alignment to perfection.

The pipe which solves culvert renewal problems with least expense, greatest efficiency. The pipe that does not rot or disintegrate, the pipe that is mechanically correct and has proved itself the solution of the culvert problem.

CONTRACTORS *and* ENGINEERS, GET THIS:

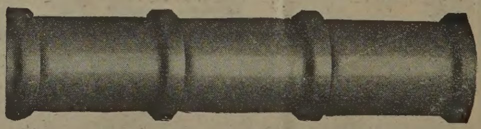
TWO MEN, without the use of any tools whatsoever, will unload, handle and install all sizes up to and including 36 inches in diameter.

It is as cheap to handle and install as clay pipe WITH NO BREAKAGE LOSS. In shallow trench work the entire culvert can be built up, interlocked and rolled into place in one operation.

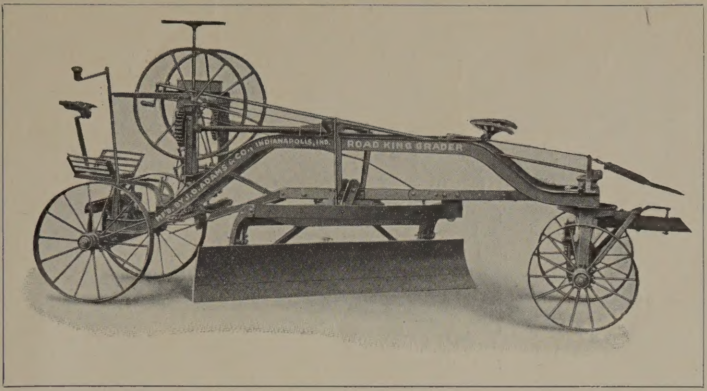


AMERICAN
CASTING CO.
Birmingham, - - Alabama

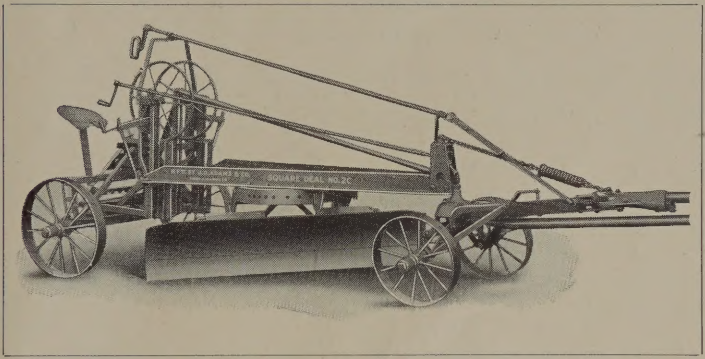
T. B. TURNER & CO.
Raleigh, : : North Carolina



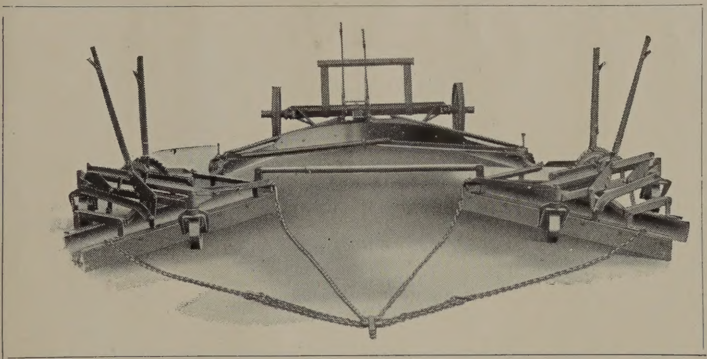
MOST MILES OF GOOD ROADS PER DOLLAR



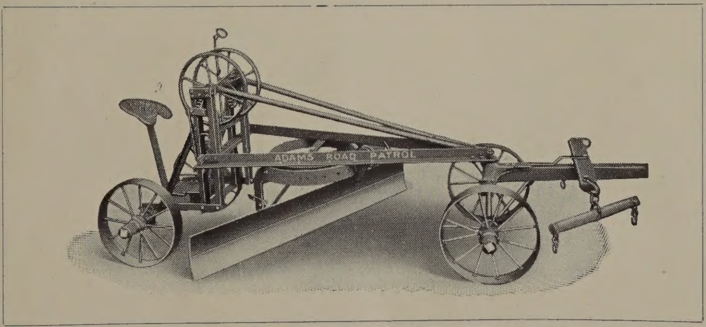
Road King Grader, 8-Foot Blade



Square Deal No. 2-C, 7-Foot Blade



Adams Road Maintainer



Adams Road Patrol Scraper

translated into working terms means Adams Road Building and Maintenance Equipment

For your road building grading use

ADAMS ADJUSTABLE LEANING WHEEL GRADERS

that are guaranteed to do more work for you with less power and therefore less cost, than any other graders on the market. The difference is in the leaning wheels—an exclusive feature on Adams Graders.

They are built with blades ranging from 7 ft. to 12 ft. long. There's a size to suit your work that can be furnished either for animal or tractor power.

To keep your roads always smooth and properly crowned, use

ADAMS ROAD MAINTAINER

a flexible machine which shapes both sides and crowns the center of the road in one operation, preserving the original contour of the road. Operated by one man and a truck or light tractor, it covers many miles of road a day, making the maintenance cost per mile very low. Adjustable to all road widths and conditions.

ADAMS ROAD PATROL

a mighty popular little one-man, two-horse maintenance machine for maintaining roads by the patrol system. Thousands in use all over the country.

We also manufacture a superior line of Road Drags, Scarifiers, Scrapers, Plows, etc.

WRITE OUR LOCAL DISTRIBUTOR

J. C. BENJAMIN, RALEIGH, N. C.

733 W. HARGETT ST.

J. D. ADAMS & COMPANY

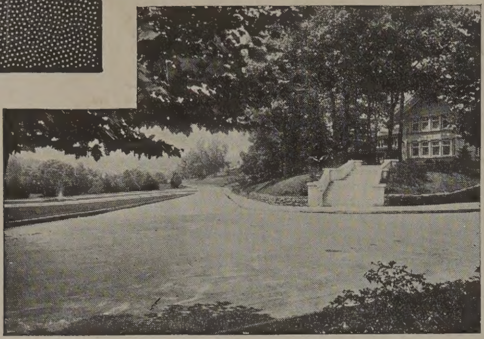
HOME OFFICE AND FACTORY

INDIANAPOLIS, INDIANA

GET IN TOUCH WITH OUR LOCAL DISTRIBUTOR — HE IS THERE TO SERVE YOU

ASHEVILLE

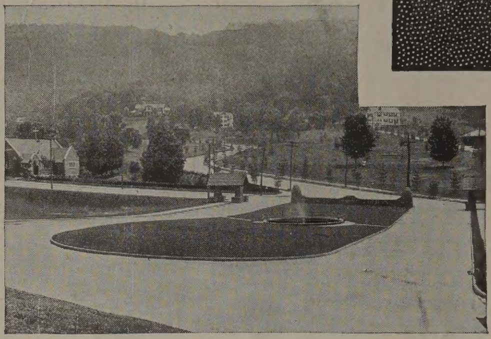
AND



TEXACO Asphaltic Concrete in the famous Grove Park Section of Asheville, N. C. This pavement was built in 1917 on old macadam.

To combine beauty with durability. That was the paving problem in Asheville, N. C., America's famous resort. This problem was solved successfully by laying TEXACO Asphaltic Concrete.

Asheville now has thousands of square yards of durable, resilient TEXACO pavements, which harmonize in beauty with the entrancing scenic surroundings.



Another view of the TEXACO Asphaltic Concrete in Asheville, N. C., which was constructed in 1917.

Just as Asheville selected TEXACO pavements, so have many other world-famed resorts found TEXACO the most durable and serviceable.

Atlantic City and Long Branch in New Jersey, Mineral Wells in Texas, Florida's far-famed resorts, and many others have pavements that last—made of TEXACO Asphalt.

TEXACO

The Texas Company

Asphalt Sales Dept., 17 Battery Pl., New York City

New York
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